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FURTHER OBSERVATIONS ON BASIC VISCOSITY OF ICE CREAM MIXES AND A SIMPLIFIED PROCEDURE TO OBTAIN IT*

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The viscosity of an ice cream mix which is quiescently aged reaches a maximum value which may be broken down by mechanical agitation to a lower constant minimum viscosity. Leighton and Williams (1) studied this phenomenon and named the two viscosities "apparent" and "basic." They reduced ice cream mixes from apparent to basic viscosities by agitating for 60 minutes in a completely filled ice cream freezer. The measuring of basic viscosities of ice cream mixes is now a common experimental procedure. Dahlberg, Carpenter, and Hening (2) used a tightly sealed fruit jar with a Daisy churn agitator to secure basic viscosity. This method has the advantages of small samples of mix and short periods of agitation as compared to that used by Leighton and Williams (1). Whitaker (3) constructed an apparatus to break apparent viscosity down to a constant basic value. Hening (4) has shown in this laboratory that if the aged ice cream mix is rehomogenized several times at low pressures the basic viscosity is lower than that obtained by the Whitaker device. This he attributed to a more thorough breaking up of the fat clumps by the homogenizer.

The fact that fat clusters in milk and cream affect viscosity was shown in 1896 by Babcock and Russell (5).

To further bear out this fact the following quotation is taken from an abstract of a paper written by Weissenberger (6) "Dispersoids, more practically emulsoids whose concentration exceeds a certain limit tend to form secondary aggregates of the primary particles of the disperse phase. These structures of higher orders are easily broken down by mechanical agitation, by shaking or forcing the solution through capillaries. If the viscosity of such an emulsion is measured in an Ostwald viscometer it is bound to fall

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off with successive passages through the capillary until a constant value is obtained, the magnitude of which depends upon the size of the capillary. If the dispersoid is then allowed to rest, the viscosity slowly increases again as the structures of higher order again are formed."

Mortensen (7) was perhaps the first to state that homogenization produced large fat clusters. Leighton and Williams (1) have shown that if an aged mix is repeatedly run through an Ostwald viscometer, the time required for the flow of the mix gradually decreases to a constant value that is dependent on the instrument itself. This is in agreement with Bateman and Sharp (8) who obtained the same results for whole milk. They further state that the reduction of viscosity was related to the breaking up of fat clumps.

In addition to the breaking up of fat clumps, it is known that agitation will break up the gel structure in ice cream mixes formed by gelatin, resulting in a reduced viscosity.

With the fact in mind that the basic viscosity as related to apparent viscosity of an ice cream mix is affected chiefly by the size and number of fat clusters and by the gel structure, a study was undertaken to determine whether a hand emulsifier is more efficient and more practical than the Whitaker device (3) in reducing apparent viscosity to basic viscosity.

EXPERIMENTAL METHOD

Preliminary trials on an ice cream mix, containing 12 per cent milk fat, 12 per cent milk solids-not-fat, 15 per cent sugar, and 0.4 per cent gelatin, pasteurized at 65.5° C. (150° F.) for 30 minutes, and homogenized with a two-stage valve at 2500 and 500 pounds pressure per square inch at pasteurization temperature and aged at 40° C. (39.2° F.) for 18 hours, showed that the hand emulsifier reduced the mix to a lower basic viscosity than the Whitaker device. The ice cream mix was emulsified twice. The mix was prepared from fresh milk, sweet cream, and dry skim milk.

In all other experiments a fat content of 10 and 14 per cent was chosen to determine the difference in basic viscosity between a high fat and a low fat ice cream mix, using Whitaker's apparatus and a hand emulsifier to obtain the basic viscosity.

The composition of the ice cream mixes were as follows: No. 1, 10 per cent milk fat, 10 per cent milk solids-not-fat, 15 per cent sugar, and 0.4 per cent gelatin; No. 2, 14 per cent milk fat, 10 per cent milk solids-not-fat, 15 per cent sugar, and 0.4 per cent gelatin. The ice cream mixes were pasteurized at 68.3° C. (155° F.) for 30 minutes and homogenized at 2500 and 500 pounds pressure per square inch at the pasteurizing temperature in a Manton-Gaulin homogenizer of a 60 gallon per hour capacity. They were then cooled on a surface tubular cooler to 4° C. and a sample was promptly taken for immediate determination of original viscosity. The

ice cream mixes after being cooled were permitted to age at 4° C. for 4 and 24 hours, after which time tests were made for apparent viscosity and basic viscosity as obtained by the Whitaker device and the hand emulsifier. The viscosities were determined between 4.2–5.4° C. in a room at 4° C. with a MacMichael Viscometer using No. 26 and No. 30 wires, and the disc bob. These wires were calibrated against oils standardized by the Bureau of Standards.

At the time that the viscosity was measured a 1 ml. sample of the ice cream mix was taken and diluted with 99 ml. of distilled water for microscopic examination of fat globules and fat clumps. All of the fat globules and fat clumps were counted and measured in the field or fields until 100 fat globules were measured. This method not only gave the average size of fat clumps and fat globules but the relative ratio of fat clumps to the fat globules, in the ice cream mix. The ocular micrometer scale was standardized to make one small division equal one micron.

In breaking down the apparent viscosity with the Whitaker device (2) the recommended time of twenty minutes was used. The hand emulsifier was operated at an average of 78 full strokes per minute. All basic viscosities were read immediately after breaking down the apparent viscosity.

EXPERIMENTAL RESULTS

It was essential to standardize the procedure with the hand emulsifier so that results could be easily duplicated. The number of homogenizations required to bring a mix to a constant basic value, the speed of homogenization, and the constancy of data secured with different emulsifiers must be known.

Two emulsifiers were used for comparison. Emulsifier No. 1 was a new instrument while emulsifier No. 2 had light service for two years. Emulsifier No. 1 was used throughout the entire investigation.

The data, table 1, show that emulsifying the ice cream mix twice was

TABLE 1

Basic viscosity of ice cream mixes at 4° C. as affected by the number of times emulsified

Mix	Number of times emulsified	Viscosity in centipoises		
		Period aged		
		0 hrs.	4 hrs.	24 hrs.
1	0	18	53	51
1	2	....	24	27
1	3	....	....	23*
2	0	36	136	271*
2	2	....	45	41
2	3	....	45	48
2	4	....	....	50

* Temperatures were one degree too high.

TABLE 2

Relation of size and number of fat globules and clumps to the number of times the mix is emulsified

Mix	Number of times emulsified	Size of fat globules and fat clumps in microns						Fat clumps per 100 fat globules		
		Average size of fat globules			Average size of clumps					
		Period aged			Period aged			Period aged		
		0 hrs.	4 hrs.	24 hrs.	0 hrs.	4 hrs.	24 hrs.	0 hrs.	4 hrs.	24 hrs.
1	0	.78	.86	....	.75 × 1.45	.60 × 1.25	....	12	14	....
1	2	....	....	.77	....	....	.61 × 1.22	....	....	9
1	3	....	....	.79	....	....	.50 × 1.00	....	....	4
2	0	.81	.82	....	1.0 × 1.73	.90 × 1.61	....	63	72	....
2	2	....	.81	.79	....	.74 × 1.29	.71 × 1.36	....	41	38
2	3	....	.78	.70	....	.64 × 1.25	.77 × 1.43	....	28	38
2	4	....	....	.76	....	....	.62 × 1.18	....	....	27

as efficient as three or four times in breaking the apparent viscosity down to a minimum. This is substantiated by the data, table 2, which show that the average size of fat globules and fat clumps and their relative numbers were not materially affected by the number of times the mix was emulsified. The hand emulsifier hardly affected the size of the fat globules. It should be pointed out that the viscosities of the two mixes, table 1, aged 0 hours which may properly be termed "original viscosity" represent both the absolute basic values which at that moment are exactly the same as the apparent viscosity. Then too, the viscosities of the mixes are apparent when not emulsified after 4 and 24 hours aging.

The data in tables 1 and 2 show that when the size of the fat clump was small the number of clumps present in the mix did not greatly affect the viscosity as compared with the effect of individual globules.

The effect of two extreme emulsifying speeds on the basic viscosity was determined. Mixes were emulsified at 36 full strokes per minute and at 120 full strokes per minute to compare with the usual speed of 78 strokes.

TABLE 3

The effect of the rate of emulsifying on the basic viscocity of the mix

Mix	Strokes per minute	Viscosity in centipoises	
		Period aged	
		0 hrs.	24 hrs.
1	0	14*	80*
1	36	....	26
1	78	....	24
1	120	....	23
2	0	37*	445*
2	36	....	61
2	78	....	56
2	120	....	54

* Temperature 2.5 to 3.7° C. Other temperatures were 4° C.

The data, table 3, show that if the mix was emulsified at the rate of 120 full strokes per minute the basic viscosity obtained was slightly lower than that obtained by emulsifying at the rate of 36 strokes per minute. The usual speed of 78 strokes gave the same results as the very high speed and was adopted throughout this study.

Since Dahlberg (9) first showed that gelatin gel is reformed in ice cream after whipping and Dahlberg, Carpenter, and Hening (2) found this regelation to be practically completed in 10 hours it is evident that basic viscosity is temporary. It was necessary to know how quickly the reading must be made after the mix had been broken down to basic viscosity. Figure 1 shows that the basic viscosity as obtained by the hand emulsifier increased as a linear function of time for the first 30 minutes. Therefore it is advisable to determine the basic viscosity within as short

a time as possible after obtaining it. The longest time that may be permitted between the time the apparent viscosity is broken down and the sample tested for basic viscosity is five minutes. This time lag does not introduce a serious error.

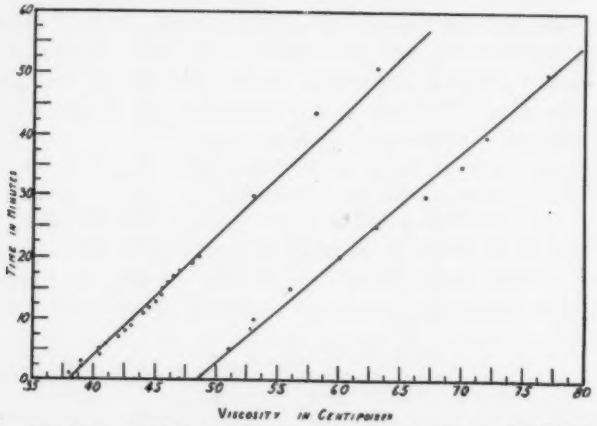

FIG. 1. The basic viscosity of two different ice cream mixes as affected by aging after hand emulsification.

It was essential to know if the results could be duplicated by another emulsifier of the same make. The apparent viscosity was broken down by two emulsifiers, one being new while the other was two years old. The data, table 4, show that the basic viscosities obtained by different emulsifiers of the same make were duplicated within reasonable experimental error.

TABLE 4

The results secured with two hand emulsifiers of the same make

Mix	Emulsifiers †	Viscosity in centipoises		
		Period aged		
		0 hrs.	4 hrs.	24 hrs.
1	...	14*	35	80*
1	1	....	16	24*
1	2	....	18	21*
2	...	37*	195	445*
2	1	....	37	56*
2	2	....	40	59*

* Temperature range between 2.4–3.5° C. instead of 4.2–5.4° C.

The hand emulsifier was then compared with the Whitaker apparatus (3) for breaking down apparent viscosity to a constant basic value. The mix was emulsified twice and immediately tested for basic viscosity. The Whitaker device was used according to his recommended procedure.

The data, table 5, clearly show that the hand emulsifier reduced mixes to lower basic values than the Whitaker device.

TABLE 5

The comparison of basic viscosities of ice cream mixes as obtained by the hand emulsifier and the Whitaker device

Mix	Type of agitation	Viscocity in centipoises		
		Period aged		
		0 hrs.	4 hrs.	24 hrs.
1	.....	18	53	151
1	Whitaker	.....	.....	47
1	Emulsifier	.....	24.5	27
2	.....	36	13.6	271
2	Whitaker	.....	.....	73
2	Emulsifier	.....	45	41
2B*	.....	37	195	445
2B	Whitaker	.....	76.0	.....
2B	Emulsifier	.....	37	.....

* Mix 2B is also a 14 per cent milk fat mix.

According to Hening (4) the difference should be due to the fact that the hand emulsifier is more efficient than the Whitaker device in breaking down the fat clumps. Both methods of agitation are supposed to be vigorous enough to break down the gel structure formed by gelatin in an ice cream mix. To see if the assumption proposed by Hening is true, the average size of the fat globules and clumps as well as the number of fat clumps per 100 fat globules were determined. The data, table 6, show that the Whitaker device was as efficient as the hand emulsifier in breaking up the larger size fat clumps. Other data, table 2, indicate that the change in basic viscosity was independent of the size of the fat clumps when the fat clumps were small. Therefore the higher basic viscosity obtained by the Whitaker device was not due to the size of the fat clumps. The increase is also not due to incorporation of air because extreme precautions were taken to prevent the incorporation of air in the mix by the Whitaker device. Therefore, a test was set up to see if both methods of agitation break down the gel structure completely.

Two samples were used in this test. Sample I consisted of skimmilk with 0.8 per cent gelatin. Sample 2 was a standard mix of 12 per cent milk fat, 10 per cent milk solids-not-fat, 15 per cent sugar and 0.4 per cent gelatin. Both samples were treated as previously described but in addition to breaking down the apparent viscosity with the hand emulsifier and the Whitaker device, the large power operated homogenizer was used with a two stage valve set at 3500 and 500 pounds pressure per square inch. The homogenizer was precooled with the ice water before the tests were made.

The temperature for reading the viscosity ranged between 5.5° C. and

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Relation of size and number of fat globules and clumps to the number of times the mix is emulsified

Mix	Number of times emulsified	Size of fat globules and fat clumps in microns						Fat clumps per 100 fat globules		
		Average size of fat globules			Average size of clumps					
		Period aged			Period aged			Period aged		
		0 hrs.	4 hrs.	24 hrs.	0 hrs.	4 hrs.	24 hrs.	0 hrs.	4 hrs.	24 hrs.
1	0	.78	.86	....	.75 × 1.45	.60 × 1.25	....	12	14	....
1	2	....	....	.77	....	....	.61 × 1.22	....	....	9
1	3	....	....	.79	....	....	.50 × 1.00	....	....	4
2	0	.81	.82	....	1.0 × 1.73	.90 × 1.61	....	63	72	....
2	2	....	.81	.79	....	.74 × 1.29	.71 × 1.36	....	41	38
2	3	....	.78	.70	....	.64 × 1.25	.77 × 1.43	....	28	38
2	4	....	....	.76	....	....	.62 × 1.18	....	....	27

as efficient as three or four times in breaking the apparent viscosity down to a minimum. This is substantiated by the data, table 2, which show that the average size of fat globules and fat clumps and their relative numbers were not materially affected by the number of times the mix was emulsified. The hand emulsifier hardly affected the size of the fat globules. It should be pointed out that the viscosities of the two mixes, table 1, aged 0 hours which may properly be termed "original viscosity" represent both the absolute basic values which at that moment are exactly the same as the apparent viscosity. Then too, the viscosities of the mixes are apparent when not emulsified after 4 and 24 hours aging.

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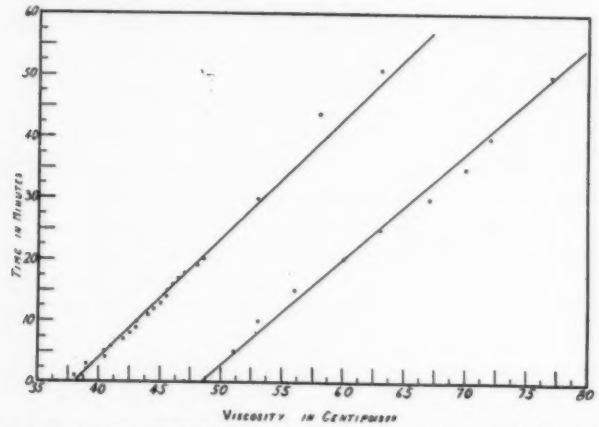

FIG. 1. The basic viscosity of two different ice cream mixes as affected by aging after hand emulsification.

It was essential to know if the results could be duplicated by another emulsifier of the same make. The apparent viscosity was broken down by two emulsifiers, one being new while the other was two years old. The data, table 4, show that the basic viscosities obtained by different emulsifiers of the same make were duplicated within reasonable experimental error.

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The hand emulsifier was then compared with the Whitaker apparatus (3) for breaking down apparent viscosity to a constant basic value. The mix was emulsified twice and immediately tested for basic viscosity. The Whitaker device was used according to his recommended procedure.

The data, table 5, clearly show that the hand emulsifier reduced mixes to lower basic values than the Whitaker device.

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2	Whitaker	.....	.....	73
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2B*	.....	37	195	445
2B	Whitaker	.....	76.0	.....
2B	Emulsifier	.....	37	.....

* Mix 2B is also a 14 per cent milk fat mix.

According to Hening (4) the difference should be due to the fact that the hand emulsifier is more efficient than the Whitaker device in breaking down the fat clumps. Both methods of agitation are supposed to be vigorous enough to break down the gel structure formed by gelatin in an ice cream mix. To see if the assumption proposed by Hening is true, the average size of the fat globules and clumps as well as the number of fat clumps per 100 fat globules were determined. The data, table 6, show that the Whitaker device was as efficient as the hand emulsifier in breaking up the larger size fat clumps. Other data, table 2, indicate that the change in basic viscosity was independent of the size of the fat clumps when the fat clumps were small. Therefore the higher basic viscosity obtained by the Whitaker device was not due to the size of the fat clumps. The increase is also not due to incorporation of air because extreme precautions were taken to prevent the incorporation of air in the mix by the Whitaker device. Therefore, a test was set up to see if both methods of agitation break down the gel structure completely.

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The temperature for reading the viscosity ranged between 5.5° C. and

TABLE 6

The average size of fat globules and fat clumps obtained by the Whitaker device and the hand emulsifier and the number of fat clumps per 100 fat globules

Mix	Type of agitation	Size of fat globules and fat clumps in microns						Number of fat clumps to 100 fat globules		
		Average size of fat globules			Average size of fat clumps					
		Period aged			Period aged			Period aged		
		0 hrs.	4 hrs.	24 hrs.	0 hrs.	4 hrs.	24 hrs.	0 hrs.	4 hrs.	24 hrs.
1	.....	.78	.86	.....	.75 × 1.45	.60 × 1.25	.....	12	14	.....
1	Whitaker	.....	.....	.76	.....	.....	.50 × 1.01	.....	.....	9
1	Emulsifier	.....	.....	.97	.....	.....	.61 × 1.22	.....	.....	9
2	"	.81	.82	.....	1.0 × 1.73	.90 × 1.61	.....	63	72	.....
2	Whitaker	.....	.....	.75	.....	.....	.73 × 1.28	.....	.....	50
2	Emulsifier	.....	.....	.79	.....	.....	.77 × 1.43	.....	.....	38
2B*	.....	1.12	1.19	.....	1.6 × 2.63	1.05 × 2.31	.....	40	40	.....
2B	Whitaker	.....	.....	1.25	.....	1.12 × 1.71	.....	.....	.....	28
2B	Emulsifier	.....	.....	1.12	.....	.93 × 1.58	.....	.....	.....	23

* Mix 2B is also a 14 per cent milk fat mix.

7.2° C. After the basic viscosity was read a sample was taken for each method and permitted to stand for 24 hours to determine the ability of the sample to regel.

TABLE 7

The basic viscosity of ice cream mix and of skimmilk containing gelatin as secured by several methods and the ability to regel

Method of obtaining basic viscosity	Skimmilk with gelatin	Ice cream mix	Viscosity of skimmilk 24 hours after being reduced to basic
Original	10	20.5	.....
4 hours of aging (apparent)	.....	122	.....
Homogenized 2-stage, 3500–500	10	27	150
Hand emulsifier	17	34	285
Whitaker device	34	42	245
24 hours of aging (apparent)	560	192	.....
Homogenized 2-stage, 3500–500	10	24	105
Hand emulsifier	19	43	177.5
Whitaker device	35	53	185

The results, table 7, indicate that the hand emulsifier was more efficient in breaking down the gel structure than the Whitaker device but that neither of them broke it down as completely as did the power operated homogenizer. The power homogenizer reduced aged solutions of gelatin in skimmilk back to the original viscosity before aging. None of the methods were capable of destroying the re-gelatinizing power of the gelatin.

DISCUSSION

The desirability of a simple inexpensive method to obtain basic viscosity of ice cream mixes is obvious. This study was undertaken to learn if the hand emulsifier is more simple, efficient, and practical than the Whitaker device in breaking down apparent viscosity to basic viscosity. The hand emulsifier may be much more readily assembled, cleaned and operated than the Whitaker device. It is also much more economical to purchase and operate.

The devices of Dahlberg and of Whitaker reduced Leighton's time of agitation and greatly reduced the size of sample. The hand emulsifier further reduced the time. Allowing two minutes for making the basic viscosity test the method used by Leighton would require 62 minutes, the Whitaker method 22 minutes and the hand emulsifier 5 minutes to break down apparent viscosity to basic viscosity and run the test.

Although the hand emulsifier is more efficient in breaking down the apparent viscosity to basic viscosity, it does not seem to be more efficient in decreasing the size of the fat clumps. It did reduce gelatin gels more completely to a minimum basic viscosity.

CONCLUSIONS

It is concluded that the hand emulsifier is simpler, more practical and more efficient than the agitation methods of reducing apparent viscosity to basic viscosity.

The difference between the minimum viscosity obtained by the hand emulsifier and the Whitaker device is not due to the size of fat clumps and fat globules, but due to the fact that the hand emulsifier is more efficient in breaking down the gel structure.

The results indicate that even though the gel structure was broken down completely, as was done by the power operated homogenizer, the gelatin used in this experiment had the power to regel without change in temperature of storage.

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EFFECT OF VARIOUS BACTERIA ON FLAVOR OF CHEDDAR CHEESE MADE FROM PASTEURIZED MILK*

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Adequate pasteurization of milk for cheddar cheese has two advantages. It insures destruction of pathogens that may have gained entrance to the milk up to the time of heating and, accordingly, is of public health significance. Also, it tends to control various objectionable fermentations when the causative organisms enter the milk preceding the pasteurization.

Experience has shown, however, that cheddar cheese made from pasteurized milk does not develop the full, characteristic flavor normally found in raw milk cheese of fine quality. It appears that during pasteurization a change occurs which interferes with development of the typical cheese flavor and also materially increases the time necessary for ripening. Whether this change is due to partial destruction of the natural bacterial flora of the milk, to action on enzymes, or to both, is not known. If the increase in time required for ripening of the cheese is due to partial destruction of the natural flora of milk by pasteurization, addition of cultures of desirable bacteria should aid in overcoming the difficulty.

The work herein reported deals with the effect of various bacteria of the genus *Micrococcus* and the genus *Propionibacterium* on flavor of cheddar cheese made from pasteurized milk. These genera were selected because of the frequency with which organisms belonging to them have been found in raw milk cheese (2, 3, 5, 7).

METHODS

Manufacture and ripening of cheese

The cheese were made in the experimental vat designed by Lane (9). This consists of five small compartments surrounded by a common water jacket, and with it the five cheese in a series could be made with approximately identical procedures. Each cheese weighed about 2.5 pounds.

The milk used came from various herds and contained approximately 4 per cent fat. All the milk was pasteurized at 61.7° C. (143° F.) for 30 minutes, so that it would have met any public health requirement, and then cooled.

In making a series of cheese, 25 pounds of the thoroughly mixed, pasteurized milk was weighed into each compartment and heated to 30° C. (86° F.); 2.5 per cent of the usual culture was then added. One lot of milk had no further inoculation and was intended as a control, while each

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of the other four was inoculated with an organism to be tested. The milk was usually ripened 30 to 45 minutes to obtain an acidity of 0.18 to 0.20 per cent, and commercial rennet was added at the rate of 3 ounces per 1,000 pounds of milk.

After 30 to 40 minutes the curd was cut with ⅜-inch knives and was not disturbed for 8 to 10 minutes, after which heating was begun. Over a period of 40 to 60 minutes the curd was heated slowly to 40° C. (104° F.) and then cooked until the acidity of the whey reached 0.16 to 0.18 per cent. The curd was milled at a whey acidity of not less than 0.45 per cent. About 30 minutes after milling, salt was added at the rate of 3 per cent of the estimated weight of curd. The salt dissolved in 30 to 40 minutes, and the curd in each vat was then placed in a hoop. The cheese were pressed for about 1 hour, removed for dressing and then replaced in the press for an additional 16 hours. They were ripened at 4.4° to 10° C. (40° to 50° F.).

Examination and scoring of cheese

The cheese were examined for flavor by two or more judges after approximately 1, 2 and 3 months of ripening. Samples were obtained with a small trier, and the trier holes were filled at once with paraffin. The cheese in a series, with the identities concealed, were ranked from 1 to 5 on the basis of the development of cheddar flavor. In tabulating the results the various cheese were recorded as being better or poorer than the control of the series.

RESULTS OBTAINED

Effect of various micrococci on flavor of cheese

The effect of micrococci was studied with 34 cultures which represented various types of micrococci isolated from cheddar cheese by Higdon (7). Twenty-three series of cheese were made; except in a very few instances, each included a control and four cheese made with different test organisms. The cultures of micrococci were prepared by inoculating into sterile milk and incubating 3 days at 21° C. (69.8° F); 0.05 per cent of such a culture was added to the cheese milk. Each culture was used in one to five trials, depending on its effect on cheese flavor.

The cultures of micrococci were divided into three groups according to their effects on cheese flavor: Those having an undesirable effect, those having no definite effect and those having a desirable effect. The allocation of a culture to a group was based not only on whether the culture gave cheese which was placed above or below the control but also on the extent to which the flavor differed.

Cultures having an undesirable effect

Seven of the 34 cultures were considered to have an undesirable effect on cheese flavor. The data obtained with them are summarized in table 1.

TABLE 1

General effect of various micrococci on flavor of cheddar cheese from pasteurized milk (Cultures having an undesirable effect)

Culture no.	No. of trials	Results after						Summary of results	
		1 month		2 months		3 months			
		No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control
1	1	0	1	0	1	0	1	0	3
2	3	0	3	1	2	1	2	2	7
3	4	2	2	0	4	2	2	4	8
4	1	0	1	1	0	0	1	1	2
5	1	0	1	0	1	0	1	0	3
6	4	0	4	2	2	1	3	3	9
7	4	2	2	1	3	2	2	5	7

The cheese made with the seven cultures commonly developed bitter or unnatural flavors. In some cases these flavors appeared rather early in the ripening process, while in others they did not develop until relatively late. Some cultures produced bitterness after 1 month but, as the cheese aged, the bitter flavor had a tendency to disappear.

Cultures having no definite effect

Of the 34 cultures, 14 had no definite effect on cheese flavor. Table 2 summarizes the data on them.

TABLE 2

General effect of various micrococci on flavor of cheddar cheese from pasteurized milk (Cultures having no definite effect)

Culture no.	No. of trials	Results after						Summary of results	
		1 month		2 months		3 months			
		No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control
8	4	1	3	2	2	3	1	6	6
9	2	2	0	0	2	1	1	3	3
10	2	1	1	0	2	2	0	3	3
11	2	2	0	1	1	0	2	3	3
12	2	2	0	0	2	1	1	3	3
13	2	1	1	2	0	0	2	3	3
14	2	0	2	1	1	2	0	3	3
15	2	0	2	1	1	2	0	3	3
16	2	0	2	2	0	1	1	3	3
17	2	2	0	1	1	1	1	4	2
18	2	2	0	1	1	1	1	4	2
19	1	1	0	0	1	1	0	2	1
20	1	1	0	0	1	1	0	2	1
21	5	3	2	3	2	2	3	8	7

A number of the cultures produced cheese that after 1 month were better than the controls, but after 3 months bitterness and other off flavors had developed. Other cultures produced undesirable flavors after 1 month, but after 3 months the cheese had improved.

Cultures having a desirable effect

Thirteen of the 34 cultures generally improved the flavor of cheese made with them. A summary of the data is given in table 3.

TABLE 3

General effect of various micrococci on flavor of cheddar cheese from pasteurized milk (Cultures having a desirable effect)

Culture no.	No. of trials	Results after						Summary of results	
		1 month		2 months		3 months			
		No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control
22	2	2	0	0	2	2	0	4	2
23	2	1	1	1	1	2	0	4	2
24	2	0	2	2	0	2	0	4	2
25	2	0	2	2	0	2	0	4	2
26	2	2	0	0	2	2	0	4	2
27	2	2	0	1	1	2	0	5	1
28	2	1	1	2	0	2	0	5	1
29	4	3	1	3	1	2	2	8	4
30	3	3	0	1	2	2	1	6	3
31	4	4	0	3	1	3	1	10	2
32	5	4	1	3	2	4	1	11	4
33	4	2	2	2	2	3	1	7	5
34	2	1	1	2	0	2	0	5	1

In general, the cultures produced flavors more or less characteristic of well ripened cheddar cheese. Some of them gave good flavors in the cheese regularly throughout the ripening period. A few, however, produced undesirable flavors after 1 month, but the cheese had improved after 3 months and were better than the controls.

Comparison of numbers of micrococci at beginning and end of ripening

With each cheese prepared by adding micrococci to pasteurized milk, a count of the micrococci was made on the fresh curd and on the cheese 3 months old. One gram of curd or cheese was ground with 9 ml. of 2 per cent aqueous sodium citrate and 0.1 ml. portions of various dilutions were spread over the surface of solidified beef infusion agar (in plates) with a sterile bent glass rod; incubation was at 21° C. (69.8° F.) for 5 to 7 days. On the surface of the agar *Micrococcus* colonies could be indentified with considerable accuracy. Although some of the micrococci may have survived

pasteurization or come from the equipment, air, etc., the colonies on the plates probably represented primarily the cultures added to the milk since the numbers of micrococci present in the control cheese were regularly very low.

Counts of the micrococci on the fresh curd varied from 100,000 to 57,000,000 per gram, while counts on the ripened cheese varied from 10,000 to 17,000,000 per gram. In general, the numbers of micrococci were lower at the end of the ripening period than at the beginning, but a few cultures gave a definite increase in some of the trials. In instances where counts were lower at the end of the ripening period than originally, there may have been a conspicuous increase and then a decrease in the numbers.

The general changes in numbers of micrococci during ripening were not related to the development of characteristic cheddar flavor. Cultures which had desirable effects on the cheese were lower in numbers at the end of the ripening than originally as often as those which gave undesirable results.

Variation in cultures belonging to the same species

The 34 cultures employed represented as varied a selection as possible of micrococci isolated from cheddar cheese. They were grouped by Higdon (7) into 23 species of which only 12 could be identified. Cultures which were classified as belonging to the same species did not have comparable effects on the flavor of cheese, which suggests that if micrococci are employed in the manufacture of cheddar cheese they should be selected on a strain basis rather than a species basis.

Effect of certain propionic acid bacteria on flavor of cheese

The effect of propionic acid bacteria was studied with seven cultures, four of which came from cheddar cheese and three from Swiss-type cheese. The general procedure was the same as with the micrococci. The cultures were prepared by inoculating the organism into tomato broth and incubating 3 days at 30° C. (86° F.); 0.05 per cent of culture was added to the cheese milk. The data are summarized in table 4.

Some of the cultures of propionic acid bacteria produced a desirable flavor in the cheese throughout the ripening period. Others produced an undesirable flavor after 1 month but developed a desirable flavor after 3 months or produced a desirable flavor after 1 month and then, as the cheese ripened, bitterness and other off flavors appeared.

Two additional series of cheese were manufactured in which very large numbers of cultures 1, 2, 3 or 4 were added to the milk. The large numbers of these organisms in cheese produced a desirable effect. Even with cultures 2 or 3, which did not improve the flavor of the cheese when used in small numbers (table 4), the large numbers were beneficial. All the cheese made with the large numbers of organisms had a very desirable flavor after ripen-

ing 3 months. Some of the cheese had a distinct sweet flavor, somewhat similar to that characteristic of Swiss cheese, but no eyes developed.

In Swiss-type cheese the growth of the propionic acid organisms results in the formation of propionates which have a desirable effect on the flavor (1). Since these organisms under certain conditions improved the flavor of cheddar cheese, the effect of calcium propionate on the flavor of cheddar cheese was investigated by adding small amounts to cheddar cheese being made into process cheese. In general, the effects were desirable. The

TABLE 4

General effect of certain propionic acid bacteria on flavor of cheddar cheese from pasteurized milk

Culture no.	No. of trials	Results after						Summary of results	
		1 month		2 months		3 months			
		No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control	No. of trials better than control	No. of trials poorer than control
1	5	1	2	2	1	3	0	6	3
2	3	1	2	1	2	3	0	5	4
3	3	2	1	1	2	1	2	4	5
4	3	2	1	2	1	3	0	7	2
5	1	1	0	1	0	0	1	2	1
6	2	2	0	2	0	2	0	6	0
7	1	1	0	1	0	0	1	2	1

amounts which were most beneficial varied with the original cheese. With the larger amounts used the flavor was too sweet and suggestive of Swiss-type cheese.

Comparison of numbers of propionic acid bacteria at beginning and end of ripening

Most of the cheese manufactured with addition of propionic acid bacteria to the pasteurized milk were examined for the numbers of these organisms at the beginning and end of the ripening period. The counts were obtained by grinding 1 gram with 2 per cent aqueous sodium citrate and preparing shake cultures in sodium lactate agar (2). Colonies showing the usual characteristics were counted as propionic acid organisms.

The counts of propionic acid bacteria on the fresh curd varied from 1,000,000 to 17,000,000 per gram, while the counts on the ripened cheese varied from 100,000 to 9,000,000 per gram. In practically all cases the numbers of the organisms were lower at the end of the ripening period than at the beginning.

DISCUSSION OF RESULTS

The data suggest that certain strains of micrococci may be useful in making cheddar cheese from pasteurized milk. These results are in agree-

ment with studies of Lane (8) and of Hansen (4), both of whom reported that an unidentified *Micrococcus* improved the flavor of pasteurized milk cheese. The products produced by micrococci, as reported by Suzuki *et al.* (10) and by Hart *et al.* (6), include compounds which presumably might have a desirable effect on the flavor of cheese.

If a *Micrococcus* is to be employed in making cheddar cheese from pasteurized milk, it should be selected on a strain rather than a species basis because of the differences between cultures apparently belonging to the same species. Such a selection is used with the propionic acid cultures employed in the manufacture of Swiss-type cheese, with the citric acid fermenting streptococci and *Streptococcus lactis* used in developing butter cultures, with the molds used in making blue cheeses and in various other fields of dairying.

The results also indicate that certain strains of propionic acid bacteria may be useful in making cheddar cheese from pasteurized milk. If such an organism is to be employed, careful selection of the strain apparently is advisable. Since the organisms normally convert some of the lactic acid to propionic and acetic acids and carbon dioxide, propionates undoubtedly are formed in the cheese, some of which have a sweet flavor. Propionates are largely responsible for the sweet flavor of Swiss-type cheese and in small amounts they may be desirable in cheddar cheese; in this connection the results obtained when calcium propionate was added to cheddar cheese being made into process cheese are suggestive.

It appears that the flavor of cheddar cheese can be influenced by a variety of bacteria, including various streptococci, lactobacilli, micrococci, propionic acid bacteria and probably other types. This general relationship suggests that a desirable flavor in cheddar cheese may not always be brought about through the action of the same combination of organisms but rather that one combination may be responsible in one lot of cheese and another combination in another lot. The great variation in flavor of cheddar cheese of good quality is in agreement with such a relationship.

Because of the public health angle and the wide application of pasteurization in the dairy industry, the manufacture of cheddar cheese from pasteurized milk will probably be extended. The general results indicate that there may be a distinct advantage in inoculating the heated milk with organisms other than the usual cheese cultures. The cheese cultures alone do not establish conditions which result in a ripening comparable to the ripening of good raw milk cheese. It may be necessary to use a combination of organisms if the pasteurized milk cheese is to be of a quality comparable to that of the best raw milk cheese. There remains the possibility that addition of one or more enzymes to the milk will be more practical than use of a combination of bacteria.

SUMMARY

1. Thirty-four *Micrococcus* cultures, originally isolated from cheddar cheese, had the following effects on the flavor when inoculated into pasteurized milk made into cheddar cheese: Seven had undesirable effects, producing bitter and unnatural flavors; fourteen had no definite effects; thirteen had desirable effects.

2. Strains of micrococci apparently belonging to the same species differed in their effects on the flavor.

3. When used in relatively small numbers, certain strains of propionic acid bacteria improved the flavor of pasteurized milk cheddar cheese, while others had no definite effects; when used in large numbers all the strains improved the flavor, and some of them produced a distinct sweet flavor somewhat resembling that of Swiss cheese.

4. The results suggest the possibility of improving the flavor of pasteurized milk cheddar cheese by the addition to the milk of various organisms other than the usual cheese cultures.

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A STUDY OF NICKING IN JERSEY CATTLE

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"Nicking" has been the subject of considerable discussion among breeders for many years. Generally speaking, this term is applied to those cases where the progeny from certain matings appear superior to those from other matings of the same animal or families. Webster defines nicking as follows: "In stock breeding, to combine well."

Breeders are constantly seeking to improve both type and production. In doing so they try different outcross matings, linebred matings, and inbred matings, hoping to purify or intensify desirable qualities. When one of these types of matings appears superior to the others it is said to "nick."

This factor of superior progeny has been noticed in other types of livestock. In Herefords it is a recognized fact that when Anxiety IV was mated to daughters of North Pole, the resulting progeny were much superior to those of other matings. In Standard Bred horses the crossing of the descendants of Peter the Great with those of Axworthy has given such superior, uniform progeny that it is known as the Golden Cross.

Hervey and Heizer (1) have shown in comparing daughter-dam groups of the various matings of three Guernsey sires that certain crosses resulted in significant differences in production. They attribute these differences to nicking. Fohrman and Graves (2) made a study of the daughters of 51 Ayrshire sires. In one case they found that the daughters of Sire 36 out of dams by Sire 11 averaged higher in production than did those daughters of Sire 36 out of dams by miscellaneous sires. In direct contrast to this an editorial in Hoard's Dairyman (3), in discussing nicking, states that the Pennsylvania State College has records of 100 proved bulls in which it finds that those proved to be prepotent in one herd were prepotent in other herds and vice versa. These conflicting opinions raise the question: "Will a bull proved to transmit high producing capacity in one herd be equally successful in another herd where a different family blood line exists?"

SOURCE OF DATA AND TREATMENT

In an attempt to throw more light on this problem a study was made in cooperation with the American Jersey Cattle Club. Register of Merit

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records were studied to see if there might be a difference in the production-capacity of various matings. Jersey bulls having the largest number of tested progeny out of tested dams were selected for analysis. It was preferable that each bull have two or more groups of daughters, each group being out of dams by one sire. It was necessary for the bull to have at least six tested daughters out of dams by one sire for each group. These requirements greatly reduced the number of bulls available for study.

Two types of comparative study were made. In the first, the groupings consisted of tested daughters out of tested dams. In the second, the groupings consisted of tested daughters only because there were not enough tested dams available. As previously stated, in grouping the animals the data include not less than six daughter-dam pairs, or six daughters in a group.

This was the smallest number that it was felt advisable to use. Davidson (4) has concluded that the average production and variability of the first fifteen daughters of a sire is representative of any larger number of tested daughters and furthermore, that on the average, six is the smallest number of first tested daughters whose average production closely approximates that of the first fifteen. His correlation of .91 between the first six and the first fifteen must be discounted somewhat however, since the first fifteen also include the first six, which would make a partial correlating of a thing with itself.

Any number of less than six daughters by this method of grouping was placed in the miscellaneous classification. If a cow had more than one daughter in a group her records were repeated as many times as she had daughters in that group.

All records were converted to a three time a day, 365 day, mature basis. Conversion factors were those used by the American Jersey Cattle Club (5). All records of less than 270 days were discarded as being abnormal. Butterfat alone was used in making these comparisons. Graves (6), Roberts (7), and Wilson (8), have concluded that milk and butterfat percentage are inherited separately with total butterfat the result of the product of these two. Thus, total butterfat would be the best single criterion to use in making these comparisons.

RESULTS

In tables 1, 2, and 4, the mean or average production of each of the groups is listed together with its probable error (P.E.) and is followed by the mean or average deviation.

Table 1 presents a summary of seventeen sires where daughter-dam comparisons were available. In examining this table it will be noticed that in most of the cases there are no apparent significant differences.

Sophie 19th's Victor seemed constant for a certain level of production

TABLE 1

Daughter-dam comparisons by sire groups

Sire of dams	Pairs	Mean and probable error		Mean deviation	
		Dams	Daughters	Dams	Daughters
A. Sophie 19th's Victor 171861					
All sires	52	725 ± 10	700 ± 8	103	86
Pogis 99th of Hood Farm	15	746 ± 15	692 ± 12	88	67
Sophie 19th's Tormentor	10	687 ± 13	708 ± 22	63	101
Miscellaneous	27	728 ± 16	702 ± 12	122	90
B. Volunteer's Dreaming Sam 261643					
All sires	27	576 ± 8	584 ± 9	61	71
Bowlina's Sultan	7	594 ± 10	596 ± 22	40	88
Miscellaneous	20	569 ± 10	580 ± 10	65	65
C. Thistle's Fairy Boy 268501					
All sires	40	515 ± 8	465 ± 5	72	48
Sally's Fairy Boy	21	550 ± 11	474 ± 7	76	48
Roberta's Golden Tycoon	11	459 ± 6	448 ± 8	29	39
Miscellaneous	8	498 ± 16	466 ± 14	67	58
D. Fauvie Maid's You'll Do 225661					
All sires	36	632 ± 8	656 ± 7	72	60
Lotus Gold Medal	11	623 ± 10	659 ± 12	48	59
Sprite's Baron	10	674 ± 17	693 ± 13	80	63
Miscellaneous	15	610 ± 12	630 ± 8	69	44
E. Sybil's Successor 258883					
All sires	37	597 ± 10	600 ± 13	89	114
Sybil's Gamboge	10	558 ± 16	624 ± 25	77	117
Miscellaneous	27	609 ± 12	591 ± 15	91	112
F. Benedictine Ruler 215113					
All sires	37	625 ± 10	585 ± 9	94	84
Jolly's Cowslip of P. H.	23	656 ± 15	600 ± 13	108	91
Miscellaneous	14	575 ± 11	561 ± 12	64	67
G. Spermfield Owl's Progress 163331					
All sires	77	709 ± 5	686 ± 5	68	63
Sibley's Choice	14	700 ± 11	689 ± 10	61	57
Sibley's Interested Prince	9	711 ± 4	679 ± 8	18	34
Sibley's Interested Owl	6	721 ± 22	704 ± 19	81	68
Sue B's Omega Choice	6	598 ± 0	715 ± 21	.....	78
Miscellaneous	42	725 ± 7	679 ± 7	70	68
H. Cedarine Golden Sultan 253221					
All sires	24	529 ± 9	541 ± 6	66	49
You'll Do's Volunteer	12	501 ± 16	570 ± 8	83	42
Imp. Nobly Born	6	526 ± 12	545 ± 9	44	32
Miscellaneous	6	587 ± 11	477 ± 18	40	65
I. Combination's Pretty Lad 205788					
All sires	66	536 ± 7	506 ± 6	87	74
Fairy Glen's Raleigh of S. V.	20	517 ± 10	470 ± 8	66	55
Topsy's Sensational Lad	10	601 ± 21	551 ± 13	107	59
Miscellaneous	36	528 ± 9	514 ± 9	79	80

TABLE 1.—(*Continued*)

Sire of dams	Pairs	Mean and probable error		Mean deviation	
		Dams	Daughters	Dams	Daughters
J. Design's Mighty Sovereign 336549					
All sires	18	664 ± 8	640 ± 9	47	54
Fauvic Maid's You'll Do	10	636 ± 8	639 ± 13	39	62
Miscellaneous	8	698 ± 8	641 ± 11	33	45
K. Owl-Interest Mercury 217413					
All sires	24	583 ± 10	577 ± 12	72	88
Raleigh's LaRilla Lad	6	604 ± 29	668 ± 19	107	68
Sultana's Virginia Lad	6	571 ± 14	554 ± 20	52	71
Miscellaneous	12	578 ± 12	542 ± 26	64	91
L. St. Mawes Lad 130501					
All sires	22	756 ± 14	813 ± 19	98	129
Rinda Lad of S. B.	7	754 ± 21	887 ± 30	82	116
Miscellaneous	15	757 ± 18	779 ± 21	105	119
M. Rosaire's Olga Lad 87498					
All sires	46	691 ± 8	682 ± 10	84	101
St. Mawes	31	689 ± 11	692 ± 12	90	103
Miscellaneous	15	693 ± 12	661 ± 17	70	100
N. Silver Chimes of S. B. 96021					
All sires	37	642 ± 8	664 ± 11	72	92
Rosaire's Olga Lad	14	678 ± 7	719 ± 19	40	103
Sampson Exile	15	624 ± 13	620 ± 13	73	73
Miscellaneous	8	615 ± 18	652 ± 21	77	90
O. Rinda Lad of S. B. 89518					
All sires	35	614 ± 6	722 ± 12	49	102
Golden Fern's Noble Jr.	7	641 ± 23	744 ± 27	90	106
Mistletoe Pogis	11	596 ± 9	684 ± 23	44	113
Miscellaneous	17	614 ± 6	738 ± 11	37	68
P. Poppy's St. Mawes 115434					
All sires	25	728 ± 10	652 ± 12	73	92
Rosaire's Olga Lad	16	745 ± 9	620 ± 16	56	96
Miscellaneous	9	699 ± 21	708 ± 17	94	76
Q. You'll Do Raleigh Oxford 169586					
All sires	36	675 ± 9	704 ± 11	81	97
LeCros	23	657 ± 10	705 ± 14	71	98
Golden Fern's Pathfinder	7	772 ± 2	732 ± 36	9	143
Miscellaneous	6	631 ± 20	665 ± 8	73	28

regardless of the production of the dams to which he was mated. Sophie 19th's Victor, Sophie 19th's Tormentor, and Pogis 99th of Hood Farm are all maternal brothers, being sons of Sophie 19th of Hood Farm. The daughters of Sybil's Successor appeared to average higher when he was mated to paternal sisters of his sire, Sybil's Gamboge 3d. However, in the miscellaneous group six of his daughters out of his own paternal sisters (by Sybil's Gamboge 3d) and out of dams by Imp. Sybil's Gamboge 4th

(a full brother to Sybil's Gamboge 3d) averaged only 474 pounds. This indicated that close inbreeding did not seem desirable.

Where Spermfield Owl's Progress was mated to dams by Sue B's Omega Choice all six daughters were out of one dam who had one lower than average record. This probably accounts for the wide difference in this group. Cedarine Golden Sultan showed a large decrease in the miscellaneous group. On closer examination of this group it was found that one daughter out of a half sister to Sultan produced only 382 pounds of butterfat in one lactation while her dam averaged 695 pounds for five lactations. Another daughter had a short time record of 378 pounds in 283 days. The remaining four daughters produced about the same as those in the other groups.

The matings of Owl-Interest Mercury and St. Mawes Lad indicate that a nicking factor might be present as do those of Rosaire's Olga Lad. In the miscellaneous group, of the matings of Rosaire's Olga Lad, three inbred daughters averaged only 513 pounds while the remaining twelve averaged 698 pounds indicating that inbreeding was not favorable. Silver Chimes of S. B. showed a decided difference in the matings to dams by Rosaire's Olga Lad and Sampson Exile. The daughters of Poppy's St. Mawes out of his paternal sisters showed a decrease as compared to matings to daughters of non-related sires.

Four of the bulls presented in table 1 indicate that the differences of the production of their daughters by various matings may be accounted for by a nicking factor. A more detailed analysis of these bulls, namely, Owl-Interest Mercury, St. Mawes Lad, Silver Chimes of S. B., and Poppy's St. Mawes, is presented in table 2. Further grouping is made by listing the maternal grandsire of the dams of the daughters in each sire group and also the immediate sire in the miscellaneous group.

The sub-grouping of the daughters of Owl-Interest Mercury shows that in the miscellaneous group those out of dams by Manora's Fairy Lad increased in production slightly over their dams. Manora's Fairy Lad is of similar breeding to Raleigh's LaRilla Lad.

Where St. Mawes Lad was mated to granddaughters of Rinda Lad his daughters averaged nearly as high as where he was mated to daughters of Rinda Lad, although there was a slight decrease from the production of their dams. Further analysis of the data shows that these four dams are out of cows that averaged only 688 pounds of fat. This increase of 190 pounds (878 minus 688) is even greater than the 133 pound increase where St. Mawes Lad was mated to dams by Rinda Lad. These figures indicate that instead of a nicking factor being present it might be that the daughters of Rinda Lad were transmitting higher production to their daughters than can be justified by their own records and regardless of the sires to which they were mated.

TABLE 2

Detailed study of matings of four bulls with indications of nicking

	Dams		Daughters		Mean deviation	
	No.	Mean and probable error	No.	Mean and probable error	Dams	Daughters
Owl-Interest Mercury						
Raleigh's LaRilla Lad	4	604 ± 29	6	668 ± 19	107	68
Sultana's Virginia Lad	3	557 ± 30	4	671 ± 20	89	58
Daisy's Prince of St. L.	1	699	2	662 ± 18	.....	37
Sultana's Virginia Lad	3	571 ± 14	6	554 ± 20	53	71
Bessie Bates Lad	2	519 ± 6	3	613 ± 25	15	63
Daisy's Prince of St. L.	1	623	3	494 ± 8	.....	21
Miscellaneous	10	578 ± 12	12	542 ± 26	64	91
Manora's Fairy Lad	3	558 ± 1	5	573 ± 21	4	70
Remainder	7	593 ± 23	7	520 ± 27	89	106
St. Mawes Lad						
Rinda Lad of S. B.	6	754 ± 21	7	887 ± 30	82	116
Miscellaneous	12	757 ± 18	15	779 ± 21	105	119
Golden Fern's Noble Jr.	2	854 ± 17	4	907 ± 28	50	83
George St. Mawes	1	862	1	608	.....	.....
St. Mawes Lad	1	990	1	960	.....	.....
Rinda Lad of S. B.	4	878 ± 15	6	866 ± 31	55	111
Remainder	8	677 ± 15	9	720 ± 18	66	78
Silver Chimes of S. B.						
Rosaire's Olga Lad	6	678 ± 7	14	719 ± 19	40	103
Sampson Exile	3	694 ± 3	10	719 ± 22	14	102
Alphena's Chief	2	583 ± 12	3	767 ± 37	30	95
King Koffee's Count	1	581	1	798	.....	.....
Sampson Exile	7	624 ± 13	15	620 ± 13	73	73
King Koffee's Count	5	648 ± 13	12	625 ± 15	69	77
Sampson Exile	1	476	2	597	.....	92
Alphena's Chief	1	636	1	607	.....	.....
Miscellaneous	5	615 ± 18	8	652 ± 21	77	90
King Koffee's Count	2	547 ± 9	4	582 ± 22	28	64
Alphena's Chief	1	668	2	803	.....	70
Silver Chimes of S. B.						
Rosaire's Olga Lad	1	819	1	630	.....	.....
Sampson Exile	1	579	1	652	.....	.....
Poppy's St. Mawes						
Rosaire's Olga Lad	10	745 ± 9	16	620 ± 16	56	96
St. Mawes	10	745 ± 9	16	620 ± 16	56	96
Miscellaneous	9	699 ± 21	9	708 ± 17	94	76
St. Mawes	4	693 ± 37	4	658 ± 12	111	37
Remainder	5	704 ± 24	5	748 ± 27	79	89

The data in table 2 did not make any appreciable change from that found in table 1 on the daughters of Silver Chimes of S. B. out of dams by Rosaire's Olga Lad and Sampson Exile. The 99 ± 23 pound difference between these two daughter groups is the most extreme of any of the cases presented. It is the only one greater than four times its probable error which would make it have statistical significance according to Holzinger

(9). This is the best example of nicking that this study was able to show.

Inbreeding did not seem favorable for Poppy's St. Mawes. In the miscellaneous group his maternally inbred daughters (St. Mawes is his maternal grandsire) showed a decrease when compared to the daughters out of dams by non-related sires.

The possible influence of relationship matings is presented in table 3.

TABLE 3

Daughter-dam comparison of type of mating for Poppy's St. Mawes 115434

	Range of inbreeding (F_x)	No. of pairs	Ave. prod. of dams	Ave. prod. of daughters	Increase or decrease
Own dam	.2500	1	910	679	−231
Paternal sisters	.1356 to .1875	10	745	620	−125
Maternal sisters	.0625 to .1250	3	621	651	+ 30
Outcross	.0000	5	704	748	+ 44

Wright's coefficient of inbreeding (10) was used to show the range of inbreeding.

In addition to the sires already presented several were studied where only daughter averages could be compared. Six of the more typical cases are presented in table 4. This phase may be of importance in a nicking study because all of the tested daughters of the sire are included. The production of the daughters of a bull are often used as a comparison when nicking is discussed and one might be justified in calling matings resulting in a higher averaging group, a case of nicking, since the production of the dams are unknown. However, the influence of the dams may be an important factor as already has been shown and for this reason too much significance should not be attached to the data in table 4.

Pogis 99th of Hood Farm seemed to mate more favorably with dams by Hood Farm Torono than he did with own paternal half sisters. Sophie 19th's Tormentor, a maternal half brother to Pogis 99th of Hood Farm appeared to mate most favorably with dams by Pogis 99th and his sire, Hood Farm Pogis 9th. The data on Sybil's Successor show that matings to dams by his sire Sybil's Gamboge 3d and to those by the full brother to Gamboge 3d, Imp. Sybil's Gamboge 4th, were not favorable but that matings to dams by his paternal grandsire, Sybil's Gamboge did seem favorable.

You'll Do's Volunteer and Masterman of Oaklands are both grandsons of Imp. Golden Fern's Noble. The linebred matings in this case appear

TABLE 4

Sires with daughter average comparisons

Sire of dams	Number	Daughters	
		Mean and probable error	Mean deviation
Pogis 99th of Hood Farm 94502			
All sires	119	684 ± 5	87
Hood Farm Torono	48	703 ± 9	90
Hood Farm Pogis 9th	17	672 ± 14	86
Hood Farm Torono 20th	14	669 ± 10	54
Miscellaneous	40	672 ± 10	89
Sophie 19th's Tormentor 113302			
All sires	101	632 ± 6	83
Pogis 99th of Hood Farm	24	673 ± 10	71
Hood Farm Torono	10	624 ± 20	93
Hood Farm Pogis 9th	6	690 ± 9	32
Miscellaneous	61	612 ± 7	79
Combination's Pretty Lad 205788			
All sires	86	505 ± 5	67
Fairy Glen's Raleigh of S. V.	23	469 ± 7	53
Topsy's Sensational Lad	12	547 ± 10	53
Westgate's Royal Majesty	7	548 ± 17	67
Brenda's Noble Prince	6	488 ± 11	41
Miscellaneous	38	509 ± 8	76
Sybil's Successor 258883			
All sires	87	600 ± 7	95
Sybil's Gamboge	11	614 ± 24	117
Sybil's Gamboge 3d	8	550 ± 27	113
Sybil's Gamboge 4th	7	553 ± 20	78
Miscellaneous	61	610 ± 8	87
You'll Do's Volunteer 238112			
All sires	77	547 ± 5	70
Xenia's Sultan	20	545 ± 11	73
Masterman of Oaklands	8	599 ± 14	58
Miscellaneous	49	539 ± 6	66
Sophie's Agnes' Laddie 179327			
All sires	62	640 ± 9	107
Sophie 19th's Tormentor	11	651 ± 19	94
Royal Majesty of St. Cloud	9	666 ± 19	85
Sophie 19th's Victor	6	720 ± 32	117
Miscellaneous	36	616 ± 12	108

more favorable than the matings to daughters of Xenia's Sultan, a non-related bull. Inbreeding also seemed more favorable in the case of Sophie's Agnes' Laddie. Sophie 19th's Victor is both a maternal brother to the sire of Sophie's Agnes' Laddie and a grandson of this same bull, namely, Sophie 19th's Tormentor.

SUMMARY AND CONCLUSIONS

In summarizing the results of this study of nicking it seems logical that there are several points to consider before one can make definite conclusions whether nicking does or does not exist among Jersey cattle. In the first place the fact that a bull has been bred to the daughters of two or three different bulls with no evidence of nicking does not necessarily mean that if this same bull is bred to the daughters of still another bull, nicking would not appear. In the second place, an apparent case of nicking may be caused by a group of dams that are transmitting higher production to their daughters than their own records would show. The matings of St. Mawes Lad indicated that the transmitting ability of the dam may be an important factor that could be overlooked in a study of this nature.

The fact that a bull may not nick as well with the daughters of one bull as he will with the daughters of another bull does not mean that this bull is a failure in the less favorable mating. This can be pointed out in the matings of Rinda Lad of S. B. When Rinda Lad was mated to dams by Golden Fern's Noble Jr. the dams averaged 641 pounds of butterfat and their daughters averaged 744 pounds. The dams by Mistletoe Pogis averaged 596 pounds and their daughters averaged 684 pounds. The mating to dams by Mistletoe Pogis did not nick as well as the mating to dams by Golden Fern's Noble Jr., but the mating to dams by Mistletoe Pogis would certainly not be called a failure.

Since close inbreeding is not a recommended practice a comparison of inbred matings to that of outeross matings is questionable for use in a study of nicking. This study has shown that inbreeding may result in increased production or it may result in a decrease when compared to other matings.

Environment is a factor of great importance that could not be considered. It could easily account for the difference in production in many of the cases. Then, too, when comparing six daughter-dam pairs to a much larger number in another group the difference may be due to a lack of sufficient data. In most cases the smaller number might be representative for the group but it would not necessarily be true in all cases.

While this study has not shown nicking to be a prevailing factor among Jersey cattle it does not justify the conclusion that nicking does not exist among Jerseys. The matings of one bull did show a pronounced difference that would be called nicking. While nicking may exist it seems quite logical that it has been used far too much as a convenient term to explain differences in production of the daughters of a bull that may be due to other causes. More daughter-dam production comparisons under similar environment are necessary to make possible a more thorough study of this subject.

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THE ADSORPTION OF THE VITAMIN A SUPPRESSING FACTOR FROM SOYBEAN OIL[1]

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In previous publications (1, 2, 3, 4) it has been shown that soybeans, when fed to dairy cows, interfere with the transference of the vitamin A potency of the ration to the milk fat secreted by the cows. It has been found that the factor responsible for this action is thermo-stable; that it is distributed in both the soybean oil and the soybean oil meal produced by either the expeller or solvent processes; that prolonged extraction of the soybeans first with ethyl ether and then with ethanol failed to completely remove this factor; and, that this suppressing action is not due to the oil itself but rather to some other factor in the beans or the soybean oil.

Although much of the vitamin A suppressing factor is held by the soybean oil meal with such tenacity as to withstand prolonged extraction with fat solvents, a considerable portion is found in soybean oil. Since the oil-free meal still possesses a suppressing action, it became apparent that this effect is not due to the oil but to some substance which is partially retained by the oil meal and partially dispersed in the oil. Therefore, it seemed logical to assume that this substance which is dispersed in the oil might be removed from the oil by suitable absorbents.

EXPERIMENTAL

The crude soybean oil used in these experiments was produced in a commercial soybean plant by the expeller process. In attempting to remove the vitamin A suppressing factor, two portions of this oil were treated with two different types of adsorbents.

As the first type of adsorbent, an activated carbon ("Nuchar") was selected. The crude soybean oil was heated to 140° C., treated with 60 grams of Nuchar per liter of oil, stirred and filtered.

For the second type of adsorbent, a synthetic sodium aluminum silicate, which has been developed by Kraybill, Brewer and Thornton, was used (5). They had found that this adsorbent possessed unusual properties for adsorbing phosphatides and associated compounds. Since the treatment of soybean oil with this adsorbent produces a clear and highly refined oil, the possibility existed that this refining process might also remove the vitamin A suppressing factor. A quantity of treated oil, which had been prepared by

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passing the crude soybean oil through a column of this adsorbent, was secured from Dr. Thornton.

In order to test the vitamin A suppressing effect of these oils, they were incorporated in the rations of a dairy cow and the effect upon the vitamin A potency of the butterfat secreted was determined. The cow received artificially dried alfalfa hay, corn silage and a grain mixture of the following composition: 4 parts, ground white corn, 2 parts ground oats, and 1 part linseed oil meal. The alfalfa hay, which was the principle source of the vitamin A (carotene) in the ration, was of excellent quality and was fed at uniform levels throughout the feeding trials. During the successive feeding periods, the grain mixture was modified by the addition of 10 per cent of the various oils to be tested. In addition to the three samples of soybean oil, cottonseed oil was used in the last feeding period to determine whether or not the vitamin A suppressing factor might also be present in this oil. The composition of the rations and the feeding schedule is given in table 1.

TABLE 1

Showing the vitamin A activity and carotene content of the butters produced by the cow on rations containing the different oils

Test period		Materials tested*	Butter	
			Vitamin A	Carotene
No.	Days		Units per gram	Micrograms per gram
1	11	(Check)	33	7.3
2	11	Crude soybean oil	19	7.6
3	11	Soybean oil treated with special synthetic adsorbent	19	7.6
4	11	Soybean oil treated with Nuchar	31	7.7
5	11	Cottonseed oil	30	7.6

* The basal ration consisted of artificially dried alfalfa hay as a source of vitamin A and a grain mixture consisting of 4 parts white corn, 2 parts oats and 1 part linseed oil meal.

Since earlier experiments (6) had demonstrated that the major effect of a ration upon the vitamin A content of milk takes place in the first ten or eleven days, eleven-day feeding periods were used in these tests. The milk during the last three milkings of each feeding period was collected, the cream separated, and churned into butter. The vitamin A potencies of these butters were determined by biological assay, using the technique previously described (1). Carotene determinations were also made upon these samples. Using the method of Schertz (7), with certain modifications (6), the samples were analyzed in a Bausch and Lomb spectrophotometer. The results of these experiments are given in table 1.

From the results of these experiments it can be seen that the butter made from the milk secreted by the cow fed the check ration (Period 1) possessed a high vitamin A value. This indicated that the potential vitamin A (caro-

tene) values of these rations were sufficiently high to insure the production of very potent butter. The lower vitamin A of the butter secured when crude soybean oil was added to the grain ration (Period 2), demonstrated the presence of the vitamin A suppressing factor in the crude soybean oil used in these experiments.

The low vitamin A potency of the butter secured in Period 3 indicates that the synthetic adsorbent did not adsorb this factor to any appreciable extent. When the cow was fed the oil treated with Nuchar (Period 4), the vitamin A potency of the milk returned to approximately the same value as that of the check ration, indicating that this adsorbent was effective in removing this factor. The comparative test with cottonseed oil indicates that this suppressing factor is not present in this oil in significant amounts.

Since a specially treated soybean oil did not suppress the vitamin A value of the butter when fed to the cow, this substantiates our earlier statement that the vitamin A suppressing action of soybean oil is not due to the oil itself but to some substance dispersed in it.

It is to be noted from the data given in table 1 that the carotene values for the different butter samples are rather uniform regardless of the vitamin A potencies of the butters. This seems to indicate that the suppressing factor interferes with the secretion of vitamin A per se in milk rather than the carotene. This peculiar effect has been observed repeatedly in earlier experiments. Furthermore, it has been observed that the carotene values as well as the vitamin A values may be lowered by additions of large amounts of either soybean oil or soybeans to the ration.

Although the Nuchar appeared to adsorb the active principle from the soybean oil, these experiments did not preclude the possibility that the factor might have been inactivated by the carbon rather than adsorbed. To test this possibility further tests were made upon the carbon. If the factor was adsorbed on the carbon, it should be highly concentrated upon the carbon and possibly might be removed by proper solvents. The removal of the active principle was attempted by extraction with acetone. The extract, after the removal of the acetone, contained much of the adsorbed oil, some sterol glucosides, coloring matter and other substances. The extracted carbon was dried and feeding tests made with both the extracted carbon and the extract as outlined in table 2.

Two Guernsey cows were given the check ration during the first period. In the second period, one cow received the extracted adsorbent and the other the extract in daily amounts equivalent to that used in the treatment of 0.8 lb. of oil. From the assays of the butter produced at the end of each feeding period, it is evident that the vitamin A suppressing factor was associated with the extracted carbon and that the extraction with acetone failed to remove any appreciable amount of this factor.

In order to eliminate the possibility of this suppressing effect being due

TABLE 2

Giving the vitamin A activity and carotene content of butters produced by the cows on rations containing the adsorbent residue and extract from the residue

Test period		Cow No.	Materials tested*	Butter	
				Vitamin A	Carotene
No.	Days			Units per gram	Micrograms per gram
1	21	535	(Check)	32	5.8
1	21	521	(Check)	33	5.7
2	21	535	Adsorbent residue	16	5.8
2	21	521	Extract from adsorbent	34	5.8

* The basal ration consisted of artificially dried alfalfa hay as a source of vitamin A and a grain mixture consisting of 4 parts white corn, 2 parts oats and 1 part linseed oil meal.

to the carbon itself and not to an active principle adsorbed upon it, feeding tests were made with the addition of the original Nuchar to the ration of two Ayrshire cows. The results of this experiment are given in table 3. Since it was found that the addition of Nuchar to the ration of the cows was without effect upon the vitamin A value of the butter produced, it must be concluded that the treated carbon in the previous experiment held the active principle. Furthermore, it must be concluded that in the treatment of soybean oil with Nuchar the action of carbon is due to adsorption rather than to inactivation of the vitamin A suppressing factor.

TABLE 3

Showing the vitamin A activity and carotene content of the butters produced by the cows on check rations and on a ration containing Nuchar

Test period		Cow No.	Materials tested*	Butter	
				Vitamin A	Carotene
No.	Days			Units per gram	Micrograms per gram
1	21	159 166	(Check)	32	4.3
2	21	159 166	Nuchar	33	4.3
3	21	159 166	(Check)	33	4.2

* The basal ration consisted of artificially dried alfalfa hay as a source of vitamin A and a grain mixture consisting of 4 parts white corn, 2 parts oats and 1 part linseed oil meal.

SUMMARY

1. Crude soybean oil was treated with two different adsorbents in an attempt to remove the vitamin A suppressing factor which interferes with the transference of the vitamin A activity of feed to the butterfat secreted by dairy cows.

2. It was found that Nuchar removed the factor from the oil while the special sodium aluminum silicate adsorbent was without effect.

3. The action of the Nuchar was proven to be that of adsorption rather than inactivation.

4. Acetone did not elute the active principle adsorbed on Nuchar although acetone did extract oil, sterol glucosides, coloring matter and other substances.

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VARIATION IN THE OXIDATION–REDUCTION POTENTIAL AS A CAUSE FOR THE OXIDIZED FLAVOR IN MILK

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INTRODUCTION

Milk is consumed because of its nutritive value and its sweet and wholesome flavor. Any abnormal flavor affects its consumption and hence is an important economic problem.

The "oxidized" flavor which will be considered in this paper has been known by a number of terms. Those most commonly used have been "oxidized," "cappy," "cardboard," and "oily." The terms "cardboard" and "cappy" were used because early workers thought that the milk bottle cap was the source of the flavor, while the other terms were used to characterize a result which workers associated with the oxidation of fats.

The origin of the flavor concerned is not known, but its development seems to be associated with an oxidation phenomenon. Though the term "oxidized" has been used it has no definite meaning, but will be used here to denote the off flavor which develops in some milks, with or without metallic contamination, when they are held at 10° C., or below, in an atmosphere containing approximately 2½ per cent of oxygen.

The presence of this flavor has caused concern in Central Europe for a number of years. Recently it has become of increasing importance in the United States. Some authorities are of the opinion that the flavor has always been present, but that it has been masked by more pronounced flavors; others think that the advances in refrigeration and methods of handling milk are indirectly responsible for the increased prevalence of the flavor.

Hammer and Cordes (1) first discussed the development of a "tallowy" flavor in milk. They found that the flavor was caused by the action of light. In a later publication Frazier (2) came to the same conclusion. These results have been confirmed by Tracey *et al.* (3) and Doan and Myers (4).

Metals, especially copper, were considered to be important factors. Their effect has been studied by Guthrie and Roadhouse (5), Golding and Feilman (6), Hunziker and Hosman (7).

Kende (8) concluded that the flavor was caused by the oxidizing action of an enzyme which he called oleinase. The enzyme was so named because he thought the enzyme oxidized the oleic acid radical of the butterfat.

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Thurston *et al.* (9) concluded that the oxidation of lecithin was responsible for the flavor.

Sharp *et al.* (10) conclude that the flavor is caused by an enzyme similar to the enzyme that destroys ascorbic acid.

Period of lactation, feed, breed, and variation in ascorbic acid have also been given as possible explanations of the development of the flavor.

Greenbank (11) after study of the oxidation-reduction potential changes in milk came to the conclusion that the flavor is caused by a mild normal oxidation of a minor constituent.

EXPERIMENTAL

Methods and Conditions Employed

This work includes most of the factors which are known to be concerned in flavor formation and is extended to include other factors which might affect oxidation, with especial consideration of the oxidation-reduction potential of the medium. The results are given herewith.

(1) The milk used in these experiments came from the Bureau of Dairy Industry herd at Beltsville, Maryland. All samples were morning's milk delivered to the laboratories in pint bottles. The samples were treated within 6 hours after milking. Except for those cases wherein the effect of heating was the subject of investigation, the data are for raw milk.

(2) Pasteurization was by the holding method; 143° F. for 30 minutes in glass bottles.

(3) All samples, unless stated otherwise, were stored at 5° C. for 24 to 48 hours.

(4) Where copper was employed, the sulfate was used. The concentration is expressed as milligrams of copper per liter.

(5) The data presented in this paper are the result of a study of over 4000 samples from about 300 cows. The data presented are results representative of the samples studied. Data on many samples are eliminated for brevity and clarity.

(6) The Eh measurements were made by the potentiometric method.

(7) A plus (+) sign indicates an oxidized flavor; a plus and minus (±) sign indicates that the judges could not determine if the flavor was present; a minus (–) sign indicates that the flavor was normal. The number of positive signs indicates the intensity of the flavor.

(8) In this work the classification of milk shall be similar to that of Thurston (12). That is; "spontaneous" milk, which does not require copper to develop the flavor; "susceptible" milk, which requires copper to develop the flavor; "non-susceptible" milk, which does not develop the flavor after the addition of small amounts of copper.

(9) An individual sample is milk from only one cow.

(10) The data on flavor are the results obtained by two judges, neither

knowing the results of the other, and neither having any knowledge of the treatment of the milk.

(11) As many data as possible were obtained on individual samples to eliminate as many variables as possible.

(12) Where possible the magnitude of the variables was changed gradually from zero to the maximum permissible.

(13) Every effort was made to handle the samples in the same manner each day. This was necessary because it has been shown that agitation and short periods at room temperature cause appreciable changes.

The Effect of Metals

Contamination of dairy products by metals is known to produce abnormal flavors. Copper and iron have been found to be the greatest offenders in this respect. To determine the relative effect of these metals a series of samples of susceptible milk were contaminated by different concentrations of the metals. Iron was added in the form of the ferrous (Fe^{++}) and ferric (Fe^{+++}) ion. Copper was added as the cupric (Cu^{++}) ion. After treatment the samples were stored at 5° C. and judged at the end of 24 and 48 hours. Table 1 shows the effect of the metals on the development of the flavor.

TABLE 1

The effect of adding copper and iron on the development of the oxidized flavor in milk

Metal added	Mg. per liter	Flavor of milk stored	
		24 hours	48 hours
None	0.00	−	−
Copper	0.07	−	+
Copper	0.15	−	+
Copper	0.22	+	++
Ferrous (iron)	0.40	+	+
Ferrous (iron)	0.80	++	++
Ferrous (iron)	1.20	+++	+++
Ferric (iron)	0.40	+	−
Ferric (iron)	0.80	±	−
Ferric (iron)	1.20	−	−

These results indicate that copper is more active as a catalyst than is ferrous iron. Ferric iron in the higher concentrations used proved to be an inhibitor to flavor formation. Since the mechanism through which the catalyst may be effective is not known, an attempt was made to find if there was a correlation between changes in oxidation-reduction potential (Eh), with the addition of metallic salts, and the tendency to flavor formation.

A number of samples of milk were selected among which were both susceptible and non-susceptible samples. The Eh of each was then determined. The same concentration of copper was added to each sample, a second Eh determination was made and the samples placed in storage. After

48 hours' storage the samples were judged to detect any change in flavor. The results are shown graphically in figure 1.

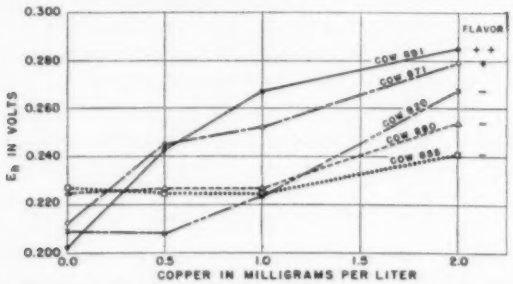

FIG. 1. The Eh's of milk samples to which different amounts of copper were added and their relation to the development of the oxidized flavor.

The values in figure 1 are in agreement with those of Hileman and Webb (13), who also noted a rise in the Eh of susceptible milk following the addition of copper. They found no correlation, however, between the oxidation-reduction potentials of milks from individual cows and their tendency to develop an oxidized flavor.

Our study of a large number of samples has shown that those exihibiting a relatively great increase in Eh after addition of copper are susceptible to flavor formation, while those with slight or no increase in Eh do not develop the flavor sufficiently to be detected by the sense of taste.

Detection of Samples Susceptible to Flavor Development

It would seem from the data just presented that it should be possible to detect susceptible samples through their change in Eh after the addition of copper. A large number of samples were studied and it was found that such a method was practical.

The test is made in the following manner. Twenty-five hundredth milligram of copper is added to 500 milliliters of milk. A copper sulfate solution containing one milligram of copper per milliliter is used. The Eh is then determined on the copper free and a copper containing sample. Both samples are then placed in storage for 6 hours and the Eh again determined. If the increase in Eh of the sample containing copper is 0.01 volt or more, the sample probably will become oxidized after 24 to 48 hours' storage at 5° C. Conversely, those samples which do not show 0.01 volt rise, probably will not become oxidized for a similar time of storage at 5° C. The values given in table 2 indicate the approximate magnitude of the Eh variation in samples susceptible and nonsusceptible to flavor development.

The test described in the previous paragraph can be used only on samples of milk which are relatively freshly drawn. The samples used were treated

within 6 hours of milking. Samples which have been shaken, or allowed to remain at room temperature for any appreciable time, may give varying results.

If a more severe control is desired, a larger amount of copper may be used. At no time should the amount be great enough to be detectable by taste or to promote other "oxidized" flavors.

These results seem to indicate that the susceptibility of a milk to flavor formation may be correlated with the ease with which its Eh changes in the

TABLE 2

Detecting susceptible samples of milk by means of the increase in Eh after the addition of equal amounts of copper

Cow No.	Eh in volts[1]			Flavor
	Plain	Copper added	Increase	
862	0.299	0.303	0.004	−
1272	0.272	0.289	0.017	+
1458	0.259	0.269	0.010	+
1355	0.247	0.253	0.006	−
1265	0.232	0.235	0.003	−

[1] 6 hours after addition of Cu.

presence of copper salts. The oxidation-reduction potential (Eh) is complicated by the poising action, which is, expressed in simple terms, the resistance of the milk to change in potential. This poising action corresponds to the buffering effect observed in measuring hydrogen ion concentration or pH. It would seem, therefore, that samples which are well poised show little change in Eh and hence do not promote oxidation reactions. Poorly poised samples, on the other hand, readily increase in Eh value, thereby promoting oxidation changes. Those samples which do not require copper to develop the flavor have much higher Eh values after the addition of copper than samples which require copper.

Many differences caused by variations in electrodes and apparatus may be compensated for by correlating the development of the flavor with the rise in Eh of susceptible samples.

The Cause of Variations in Susceptibility of Individual Milks

The variation in susceptibility of the milk from different cows has been one of the facts difficult to explain. Kende (8) explained it by the absence of the enzyme or by variations in the amount of reducing substances. The variation would seem to be more difficult to explain if in keeping with this theory the substance causing the flavor is always present. The variation is explained in this paper by the use of one variant—the poising action of the milk. If a sample is well poised at a low Eh the flavor will not develop. If poorly poised, the sample increases in Eh with contamination and the

minor constituent oxidizes to give the oxidized flavor. The effect of differences in handling and insignificant contaminations are reflections of poor poising.

Using poising as a criterion and Thurston's classification (12), spontaneous milk may be very poorly poised, susceptible milk poorly poised, and nonsusceptible milk well poised. That is, this classification may be expressed in terms of the poising action of the milk.

The Effect of Different Feeds

Kende (8) found that feeding of green hay, or adding water extracts of green hay to the milk prevented development of the flavor. He assumed that the reducing substances in the green feed acted as antioxidants, thus preventing flavor formation.

Data are presented in table 3 on milk from cows that had been on dry feed for six months or more and were then put on pasture. Samples of the milks had been collected, stored, and scored prior to pasturing of the cows, and a similar procedure was followed at intervals during pasturing.

TABLE 3

The intensity of the oxidized flavor of milk from cows on pasture for varying periods of time

Cow No.	Flavor[1]			
	0 wk. on pasture	5 wk. on pasture	10 wk. on pasture	16 wk. on pasture
N–429	+++	++	++	++
N–219	+++	–	–	–
N–419[2]	++++	+++	+++	+++
A–103	++++	–	–	–
A–108	++	–	–	–

[1] 1 mg. of copper per liter.
[2] Recently fresh.

According to these data the development of the flavor is not always inhibited by feeding green feed. However, its beneficial effects are indicated by the fact that in every case there was a decrease in flavor intensity by the end of the fifth week. In experiments previously recorded, it has been shown that in susceptible milk samples there is an increase in the Eh after the addition of copper. Since this does not occur with certain samples of milk from cows that have been placed on pasture, a logical deduction would be that in those cases the poising action of the milk has increased. A study was, therefore, made to determine the variation in poising action when animals were placed on pasture, and the time that might be necessary to bring about the change. The data are given in figure 2.

Before the pasturing of cows 820, A-103, and A-99, the addition of 1 mg. of copper to a liter of their respective milks caused an increase in the Eh

values, and an oxidized flavor developed in each sample. After the cows had been on pasture for two weeks the addition of a similar amount of copper caused very little change of the Eh, and no flavor developed in the milks. The milk from cow A-105 changed little in Eh value after the addition of copper, even after the animal went on pasture. The results obtained seem to indicate that milks vary in their poising action. On this basis it may be said that the milk from cow A-105 was so well poised that addition of copper or reducing substances did not affect the Eh value greatly. The milks from cows 820, A-103, and A-99, on the other hand, may be said to have been poorly poised before the cows were put on pasture. Should the poising

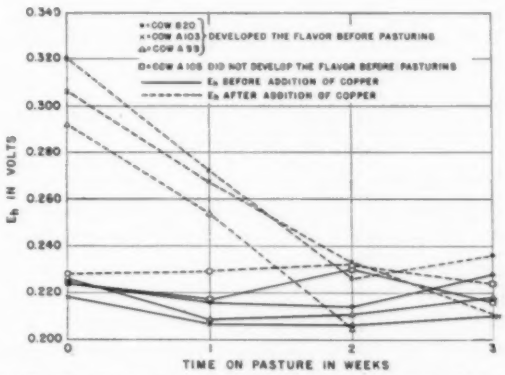

FIG. 2. The Eh of milk from cows at various stages of pasturing, before and after the addition of copper, and the effect upon the development of the oxidized flavor.

action of a milk be strong at a high potential, the flavor will develop while the cow producing the product is on pasture as well as when on dry feed except possibly for a slight difference in its intensity. The governing factor in the tendency of a milk to flavor development seems, therefore, to be its poising action.

The Effect of Different Storage Temperatures on the Intensity of the Oxidized Flavor in Milk

It is a well-known fact that the oxidized flavor developed by milks held in storage increases in intensity with decreases in storage temperatures. This is also evident from data obtained by Bell (15) upon frozen evaporated milks. These data are given in table 4.

Those samples stored at – 17° C. developed an oxidized flavor sooner and retained the flavor for a longer period than did those stored at – 7° C. The explanation for this fact lies probably in the effect of dissolved oxygen at different temperatures upon the relative rates of two or more successive

TABLE 4

The effect of time and temperature of storage on the development of the flavor

Storage (weeks)	Flavor	
	Storage temperature	
	−7° C.	−17° C.
0	good	good
1	good	oxidized
2	oxidized	oxidized
3	oxidized	oxidized
4	oxidized	oxidized
5	sl. oxidized	oxidized

reactions that may be involved in the formation and destruction of the flavor. (See discussion.)

The Effect of Variation in the Time of Adding Metals on the Intensity of the Flavor

It is a well-established fact that metallic contamination before pasteurization does not produce as intense an oxidized flavor as contamination after pasteurization. Brown *et al.* (14) were the first to point out this fact, but they gave no explanation for this phenomenon.

The conclusions of Brown *et al.* (14) have been confirmed through a number of experiments on samples to which copper had been added before and after pasteurization treatment. Other experiments were carried out to determine the relationship between flavor formation and the changes of potential when copper is added before and after pasteurization. The results are shown in figure 3.

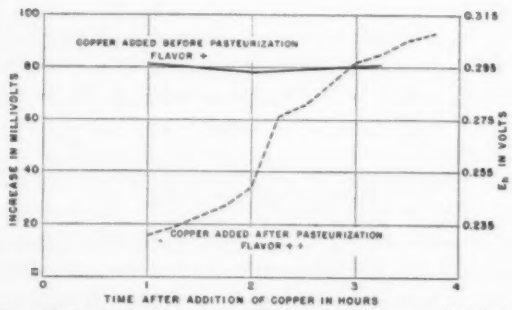

FIG. 3. The effect of the time of addition of copper on the development of the oxidized flavor and the Eh.

The Eh value of the milk sample to which copper was added before pasteurization changed but slightly after the sample was placed in storage, while that of the sample contaminated after pasteurization rose gradually

throughout the storage period and finally attained a value greater than that of the former sample. The fact that the sample to which copper was added before pasteurization does not reach as high an Eh value as the sample treated with copper after pasteurization is probably because of the formation of copper protein salts during heating.

The Effect of Heating

The inhibition of flavor production caused by the heating of milk has in most cases been ascribed to the destruction of a specific enzyme "oleinase," described by Kende (8) and so named by him because he thought it promoted the oxidation of the oleic acid radical of the fat glycerides. Sharp (10) holds a similar view and concluded further that this enzyme is similar to the enzyme that oxidizes ascorbic acid, and that both enzymes are destroyed by heat. The heat treatment of milk necessary to prevent flavor development is 185° F. (85.0° C.) for 5 minutes, according to Kende (8); 170° F. (76.6° C.) for 10 minutes, according to Sharp (10); and heating to 170° F. (76.6° C.), according to Dahle (16).

Aside from the isolation by Kende (17) of an albumin-globulin fraction, which he claims contained the enzyme, no work has been done to prove its existence. Its presence has generally been assumed and the effect of heat has been ascribed to the inactivation of an enzyme and the production of reducing substances.

To determine the effect of heating milk upon its tendency to produce flavors, the following experiments were performed. After determination of the Eh of a raw milk, samples of it were heated to different temperatures, cooled, and the Eh of each determined. The results are given in table 5.

TABLE 5

The effect of heating milk at different temperatures upon the Eh

Time of heating	Heating at 63° C.		Heating at 70° C.		Heating at 85° C.	
	Change in volts	Eh	Change in volts	Eh	Change in volts	Eh
min.						
0	.....	+0.273	.....	+0.273	.....	+0.273
1	+0.005	+0.278	−0.011	+0.262	−0.033	+0.240
5	−0.002	+0.271	−0.025	+0.248	−0.042	+0.231
10	.....	.....	−0.048	+0.225	−0.048	+0.225
15	−0.008	+0.265	.....	.....	.....	.....
30	−0.017	+0.256	.....	.....	.....	.....

Heating, at those temperatures shown by other workers to inhibit flavor formation (170° F. (76.6° C.) and 185° F. (85° C.)), markedly decreases the Eh of the milk, thereby indicating a stronger reducing tendency. Though the Eh was not decreased so greatly in the samples heated at 145.2° F. (63° C.) for 30 minutes as it was in those samples heated at 158° F.

(70° C.) and 185° F. (85° C.), there was no indication from these data or data on a great number of other samples studied that this heating increased the susceptibility to flavor formation. These data are in contradiction to those of Dahle (16) and others who have found that pasteurization promotes the development of flavor. From the above given data it seems probable that the prevention of vitamin C destruction and flavor development may be caused by the decrease in Eh, that is, a greater reducing tendency of the system.

The Effect of Bacterial Growth

The inhibiting action of bacterial growth was one of the first observations made by early workers in the field. Kende (17) and Dahle (16) attribute this action to the formation of reducing substances.

In order to study the effect of bacterial growth upon the development of flavors, samples of a susceptible milk were stored at different temperatures to obtain differing amounts of growth. Bacterial count and Eh determinations were made and samples cooled or warmed to the temperatures indicated in table 6. After 48 hours' storage at these temperatures the bacterial count and the Eh were again determined and the samples scored for flavor. The results are given in table 6.

TABLE 6

Effect of bacterial growth on the Eh and the development of the oxidized flavor in milk

Temperature	Eh	Bacterial count	Flavor
° *F.*			
41 (5° C.)	0.341	5,800	+++
50 (10° C.)	0.321	59,000	++
57.4 (14° C.)	0.307	1,080,000	+
68.0 (20° C.)	0.165	109,000,000	−

As was to be expected, no flavor developed in the milk stored at 68° F. (20° C.), in which the Eh value dropped to 0.165 volts. The samples at 57.4° F. (14° C.), 50° F. (10° C.) and 41° F. (5° C.) increased in intensity, respectively. With this increased intensity there was a respective increase in Eh.

The Effect of Variation in Ascorbic Acid

The variation of the ascorbic acid content of milk has been suggested as a cause for the oxidized flavor by Kende (8); Dahle (16), and Sharp (10), have also studied its effect in this respect.

Ascorbic acid (Vitamin C) is a reducing agent and the Eh in water solution as determined by Ball (18) appears to be low enough to inhibit development of the flavor, were it caused by an oxidation.

Experiments were, therefore, conducted to determine if the amounts of ascorbic acid necessary to inhibit flavor formation would fall within the range of values for the amounts of this compound normally present in milk.

Most of these experiments were conducted with raw herd milk, though some susceptible and non-susceptible samples from individual cows were used. The ascorbic acid was added in crystalline form and the samples judged at the end of 48 hours in storage.

TABLE 7

The effect of ascorbic acid (vitamin C) on the development of the oxidized flavor in milk

Cow No.	Flavor when ascorbic acid was added at the rate of			
	0 mg. per liter	10 mg. per liter	20 mg. per liter	40 mg. per liter
N–419	+	+	±	−
N–429	+	+	±	−
A–65	−	−	−	−
N–219	−	−	−	−

The results indicate that the presence of ascorbic acid can prevent the production of oxidized flavor; however, the amounts required are greater than the probable normal variations in this constituent, 22.2 to 29.2 mg. per liter, Whitnah (19).

Removal of the Oxidized Flavor in Milk by a Reducing Agent

The inhibition produced by bacterial growth, green feed, and heating is caused by an increase in reducing substances, as reflected in the lower Eh values of the milk.

An attempt was made to ascertain if the oxidized substance responsible for the flavor could be rendered innocuous by the action of a reducing agent. To do this, different amounts of sodium sulfite (Na_2SO_3) were added to samples which had just become positive and the samples stored at 4° C. for 24 hours. After storage the Eh of the samples was determined and the samples judged for flavor. The results are shown in table 8.

TABLE 8

The effect of a reducing agent (Na_2SO_3) on the oxidized flavor in milk

Mg. Na_2SO_3 per liter	Eh	Flavor	
		Judge No. 1	Judge No. 2
0	0.304	++	++
1	0.281	++	+
2	0.273	±	+
4	0.241	±	+
8	0.220	−	−
16	0.191	−	−

As the concentration of sodium sulfite increased the Eh decreased and the flavor became less pronounced and at a concentration of 8 milligrams per liter the flavor was not discernible by the sense of taste. As previously

indicated, this type of experiment cannot be carried out on milk in which the flavor has been taken up by the fat and protein. This is not absolute proof that the precursor is regenerated by reduction but seems to indicate that such is the case.

The Effect of the Removal of Air on the Development of the Oxidized Flavor in Milk

According to Sharp (10) removal of air inhibits the development of the oxidized flavor in milk. Studies made in these laboratories indicate that the development of the flavor is inhibited if the concentration of copper is low. This inhibition is probably caused by the removal of oxygen which reduces the Eh value of the milk. The addition of a high concentration of copper increases the Eh and the flavor develops.

The Effect of Light

In the experiments recorded here an attempt was made to find the effect of light upon the development of the flavor and upon the Eh of the milk. Samples of non-susceptible milk with and without copper were exposed for varying lengths of time to the diffuse light from a western exposure. At the end of the exposure the samples were placed in storage at 41° F. (5° C.) for 48 hours and were scored. The Eh values were determined before and after exposure. The results are given in table 9.

TABLE 9

The effect of diffuse light on the Eh and the development of the oxidized flavor in milk

Exposure	Copper per liter	Eh	Flavor
hr.	*mg.*	*volt*	
0	0.5	0.234	−
3	0.0	0.228	−
3	0.5	0.257	++
6	0.0	0.242	−
6	0.5	0.246	+

The results in table 9 agree with those of experiments with several thousand samples, in that ordinary exposures to light of uncontaminated samples do not affect the flavor. In the presence of copper an exposure of 3 hours promotes the development of the flavor and increases the Eh more than does 6 hours' exposure. In all probability light in the presence of copper is such a strong oxidizing agent that prolonged exposure causes a reaction similar to that of the ferric ion shown in table 1.

After the study of the effect of diffuse light an attempt was made to determine the action of direct sunlight. In this experiment a number of samples of non-susceptible milks were exposed to the direct February sun in pyrex flasks. Pyrex was used because of its high transmission in the ultra-

violet end of the spectrum. Some of the samples contained copper. The approximate temperature was 32° F. or 0° C. During exposure and at definite intervals afterward, the Eh of the samples was determined. After the exposure the samples were held at 5° C. and judged at the end of 48 hours' storage. Figure 4 shows the effect of sunlight on the flavor and Eh of non-susceptible milk.

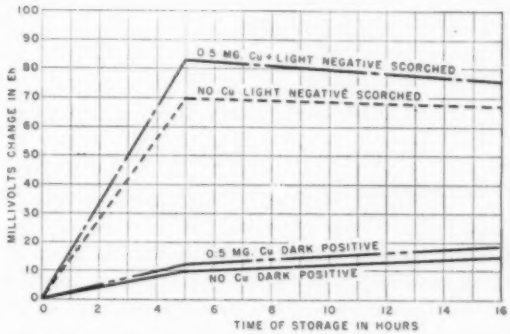

FIG. 4. The effect of sunlight on the Eh and the development of the oxidized flavor in milk.

Direct sunlight with its shorter wave lengths is so strong an oxidizing agent that it increases the Eh so greatly and so rapidly that a scorched flavor results. Experiments described elsewhere on the effect of hydrogen peroxide and contamination before pasteurization indicate that a rapid rise in Eh is not conducive to the development of the flavor.

The Promotion and Inhibition of the Oxidized Flavor in Milk by Oxidizing Agents

It has been shown by Greenbank (11) and also in table 1 that the oxidized flavor in milk may be destroyed by increasing the tendency toward oxidation. In the experiments quoted no attempt was made to measure the oxidation-reduction potential of the milk in question.

An attempt was then made to form the oxidized flavor by a low concentration of the oxidizing agent and destroy the flavor by a higher concentration of the chemical. The changes in intensity of oxidation were followed by means of the increase in the Eh. A susceptible milk was treated with different concentrations of hydrogen peroxide (30 per cent) and placed in storage for 4 hours. The samples were then removed, the Eh determined, and the samples judged. The results of this experiment are given in table 10.

The results were repeated a number of times on different samples. No two samples gave exactly the same results but all showed the same trend.

TABLE 10

The promotion and inhibition of the oxidized flavor formation in milk by hydrogen peroxide

Concentration of of 30% hydrogen peroxide per liter	Eh	Flavor	
		Judge No. 1	Judge No. 2
cc.	*volt*		
0.00	0.231	−	−
0.03	0.291	±	+
0.06	0.354	+	+
0.12	0.392	++	++
0.20	0.431	+	+
0.50	0.410	−	−

The Effect of Variations in the Hydrogen-ion Concentration

The Eh of reversible oxidation-reduction systems change with variation in their respective H-ion concentrations. The effect of variations in the H-ion concentration of milks susceptible to flavor development was promoted or retarded in accordance with known variations in H-ion concentration. Samples of "spontaneous" milks were treated with lactic acid or sodium hydroxide to obtain a desired pH, stored at 41° F. (5° C.) and scored at 24- and 48-hour periods. The data are given in table 11.

TABLE 11

The effect of varying the pH in the same milk on the development of the oxidized flavor

pH	Flavor	
	After 24 hr. storage	As ranked by judges after 48 hr. storage
6.90	−	1
6.79	−	2
6.65	−	3
6.55 (control)	+	4
6.49	+	6
6.32	+	5
6.25	+	6
6.01	+	5

The data indicate that a decrease in the H-ion concentration of the milk equivalent to 0.10 pH unit is sufficient to inhibit the development of flavor for 24 hours. Though the flavor develops in 48 hours, those samples with decreased H-ion concentration produced less flavor than any of the samples of increased acidity.

These conclusions are in agreement with former results of Greenbank (11) confirmed by Anderson (21). The latter author, however, explained the effect on the supposition that the neutralizer is an activator of an enzyme which destroys flavor, rather than upon the theory of catalysis of oxidation by the OH-ions.

The Effect of Antioxidants

The use of antioxidants is so general today that any study of a chemical oxidation would not be complete without their application. The mechanism of antioxygenic action is not well understood; therefore, many of the properties used to determine whether or not a substance will oxidize cannot be used. However, an attempt was made to determine if the antioxidant hydroquinone would counteract the action of copper. A number of samples of a susceptible milk were treated with hydroquinone or copper, and certain samples were treated with both. After treatment the samples were placed in storage and judged at the end of 48 hours. Table 12 shows the effect of hydroquinone on the development of the flavor.

TABLE 12

The effect of hydroquinone on the development of the oxidized flavor in milk

Treatment		Flavor	Score
Hydroquinone	Copper		
mg. per liter	*mg. per liter*		
0.0	0.0	++	4
0.5	0.0	+	3
1.0	0.0	−	1
0.0	0.5	+++	6
0.5	0.5	++	5
1.0	0.5	−	2

Hydroquinone proved to be an effective antioxidant in preventing the development of the flavor. Two parts of hydroquinone were required to counteract the action of one part of copper.

Incidentally, it may be stated that although some samples did not develop the flavor, those containing only hydroquinone were always judged of superior quality. This observation would seem to indicate that there may be other types of oxidation which affect the flavor and which are not considered highly objectionable.

Controlling the Development of the Flavor by Variations in the Oxidation Reduction Potential (Eh)

It has been shown in experiments heretofore described that heating reduces the Eh and inhibits the development of the oxidized flavor in milk. Since the poising action of milk varies, it is possible that the respective change in Eh value resulting from heat treatment may vary in degree. In some cases the poising action may be so great that the decrease in Eh upon heating may be too small to prevent flavor development even when copper is present. To determine if this is the case, a number of samples were selected and heated to 185° F. (85° C.) for 5 minutes. After cooling, copper was added in different concentrations and the samples stored at 5° C. for 48 hours. The results are given in table 13.

TABLE 13

The effect of heating milk to 185° F. (85° C.) for 5 minutes on copper as a catalyst for the development of the oxidized flavor in milk

Cow No.	Flavor when copper was added in the concentration of				
	0 mg. per liter	0.15 mg. per liter	0.2 mg. per liter	0.4 mg. per liter	0.8 mg. per liter
A–110	–	–	–	–	+
N–222	–	–	–	–	+
N–415	–	–	–	–	–
N–418	–	+	+	+	+
N–419	–	+	+	+	+
N–420	–	+	+	+	+

The data seem to indicate that any sample may become oxidized if sufficient copper is added. They also seem to indicate that the reducing substances formed by heating may be oxidized by the copper and the Eh increases to a point which favors flavor development. An attempt was made to test this hypothesis.

Heating raw susceptible milk to 158° F. (70° C.) for 10 minutes has been shown to decrease Eh and inhibit development of the flavor. The addition of copper to raw "susceptible" milk has been shown to increase the Eh and promote the development of the flavor. Since heating reduces and the addition of copper increases the Eh, it should be possible to heat a copper-containing milk and obtain the same Eh as the raw milk. If an increase in Eh alone is responsible for the development of the flavor, the addition of more copper to the heated copper-containing milk should cause an increase in Eh and promote development of the flavor.

The results in table 14 show that if sufficient copper is added to a heated sample, it will develop the flavor.

TABLE 14

Controlling the development of the oxidized flavor in milk by varying the Eh

Sample No.	Treatment	Eh volt	Change in Eh volt	Flavor
1	Raw	0.222*	.000	–
2	Raw + 1 mg. Cu per l.	0.232*	+.010	+
3	Heated milk + 1 mg. Cu per l.	0.192*	–.030	–
4	1 mg. Cu per l. added before heating	0.222	–.000	–
5	Same as (4) + 1 mg. Cu after heating	0.235*	+.013	+

* After 6 hours' storage.

By raising or lowering the Eh value of the same milk, it has been possible to promote or inhibit the development of the oxidized flavor.

The relation of the changes in the Eh of the milk to the development of the oxidized flavor and the probable reaction are shown in figure 5.

DISCUSSION

The results of the experiments described in this manuscript seem to indicate that the oxidized flavor of milk is caused by a mild oxidation of some minor constituent or constituents. This conclusion is supported by the fact that in a reducing environment, such as that caused by the mechanical removal of air, removal of oxygen by bacterial growth, or presence of antioxidants, etc., the flavor does not form readily. On the other hand, conditions

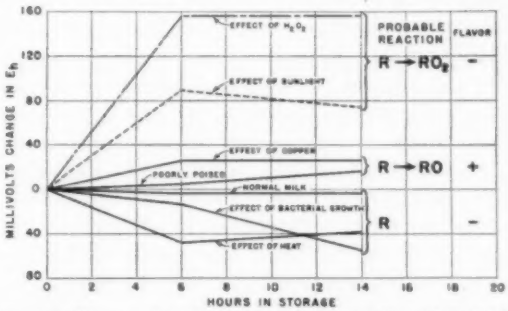

FIG. 5. Summary diagram, based on a number of results obtained showing the relationship of variation in the oxidation reduction potentials of milks to the development of the oxidized flavor.

favoring mild oxidation, such as low temperatures of storage, presence of certain metals that catalyze oxidation reactions, or subjection to the action of diffused light in the presence of metals, action of small amounts of hydrogen peroxide, etc., favor flavor formation. However, flavor development is also inhibited by heating the milk, by the action of certain concentrations of hydrogen peroxide or by the presence of oxygen (aeration) etc. Conditions favoring oxidation seem therefore to be able to promote or inhibit flavor formation, depending upon their intensity. This fact seems to be most satisfactorily explained through the assumption that two stages of oxidation are involved; namely, oxidation of the compound or compounds involved to intermediate compounds which possess the flavor or to more completely oxidized compounds that are tasteless.

Schematically, such an oxidation may be represented as follows:

R ⟶	RO ⟶	RO_2
No oxidized flavor	Oxidized flavor	No oxidized flavor

Thus, when mild oxidizing conditions exist the oxidized flavor develops. Under more strongly oxidizing conditions the reaction proceeds to a more complete stage and the oxidized flavor does not develop.

Furthermore, the results obtained with milks stored at different temperatures may best be explained upon the assumption that the rates of reaction of the stages of the oxidation are different and are affected to different degrees by temperature changes.

Such a theory serves to correlate most satisfactorily the observations recorded here, as well as those made by other workers, concerning the development of the flavor without resorting to explanations based on assumed enzyme activity.

All of the major constituents of milk are relatively stable to mild oxidizing conditions, and especially under those conditions which are known to affect flavor formation. This would seem to eliminate the glycerides of the fat, casein, lactose and albumin, as precursors of the flavor.

Since the oxidation concerned seems to be affected greatly by mild oxidizing or reducing conditions, it seems that this state is most satisfactorily explained by the variations in oxidizing and reducing tendencies of the milk in question. That this may be the case is supported by the data presented. Under conditions which increase the oxidation-reduction potential of the milk, flavor development is favored. However, strong oxidizing action may inhibit the flavor development primarily through completion of the oxidation as heretofore explained. Conversely, a lowering of the oxidation-reduction potential favors inhibition of flavor formation. These facts indicate that there is a direct relationship between the potential of the system and the tendency of a milk to develop off-flavors. Copper is an ideal catalyst for flavor development because the Eh value of the milk when this metal is added is great enough to promote oxidation but not great enough to promote a rapid oxidation of the reaction concerned to completion. There seems also to be a variation in the poising action of different milks. Milks which do not readily develop the flavor seem to be well poised while those milks which develop flavor increase in potential with the addition of small amounts of copper and develop oxidized flavors. Heating the milk or feeding the animals producing the milk on green feeds seems to increase poising action, thereby inhibiting flavor development.

The fat has often been considered as a probable precursor of the compounds that are responsible for the flavor. Though changes in the iodine number of fats with changes in flavor have been observed by Dahle (16), and by Kende (8), no changes were observed by Brown *et al.* (22). The latter observation seems to be in accord with the work of Holm and Greenbank (23), who observed that fresh milk fat is relatively stable to spontaneous oxidizing action even at relatively high temperatures and that sufficient oxidation to produce tallowy flavor affects the iodine value but slightly. These facts seem to exclude the glycerides of fat as possible precursors of the compounds that are responsible for the flavor but does not necessarily exclude minor fat constituents, such as lecithin, which compound Thurston (9) has suggested is indirectly responsible for the flavor.

Oxidizing conditions which have little effect on the major constituents of milk are capable of inhibiting the development of the flavor in milk and the fact that the flavor develops to a greater intensity as the storage tem-

perature is decreased does not support the idea that a major constituent of the milk is concerned.

The theory that enzymic action is responsible for the flavor is not easy to support in view of the evidence presented; namely, that the flavor developed to a greater intensity at a storage temperature of 1.4° F. (−17° C.) than at higher storage temperatures, that flavor developed in milk samples heated to 185° F. (85° C.) for 5 minutes, and that flavor did not develop in aerated samples of the same milk (10).

On the basis of the proposed theory, the anomalous fact that flavor develops more rapidly and to a greater intensity in milk stored at 1.4° F. (−17° C.) than in milk stored at 19.4° F. (−7° C.) may be viewed as a result of a decreased rate of oxidation by dissolved oxygen to the more completely oxidized stage brought about by the lower storage temperature. The net result is an accumulation of the intermediate or flavored compound.

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EQUILIBRIUM SOLUTIONS OF CERTAIN LACTOSE–SALT MIXTURES

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Although the solubility characteristics of lactose in water have been rather extensively studied (10, 14, 5), recorded data concerning the melassigenic properties of various salts are extremely meager (11). This lack of comprehensive or critical data has imposed certain limitations in adequately dealing with some industrial processes and developmental research in which the crystallization of lactose is directly or indirectly concerned. The literature discloses substantially only one series of data concerning the solubility of lactose in known salt solutions, namely, the work of Herrington (11) involving calcium chloride, which incidentally led to the isolation of a lactose-calcium chloride compound. Since the formation of calcium chloride compounds with other sugars has been reported (3, 1, 8, 16), the evidence might be interpreted to indicate a particular molecular configuration especially conducive to compound formation with this salt and possibly other salts with closely related properties. The purpose of the present work had a two-fold objective: first, to determine the influence of various salts upon the solubility of lactose, thereby ascertaining whether certain ions exhibited an orderly relationship in melassigenic properties; and secondly, to determine whether other calcium-halide compounds analogous to calcium chloride-lactose compounds could be formed under appropriately controlled conditions.

EXPERIMENTAL

The lactose employed in this study was the alpha hydrate which fully conformed to the U. S. Pharmacopoeia specifications, of a degree of fineness which permitted passage through a 120-mesh screen. The salts were of the "chemically pure" and "tested purity" class with the exception of the calcium bromide and calcium iodide which were labeled "pure." No further purification was attempted. The following procedures were used in carrying out the solubility determinations:

(A) The salt solutions were prepared in graduated concentrations at five per cent intervals by adding the required amounts to 50 grams of distilled water. Salts containing water of crystallization were either dried to the anhydrous form or, when this procedure was impracticable, appropriate calculations were made to determine the equivalent of the anhydrous material. The standardized salt solutions were placed in screw-cap bottles, which in turn were attached to a vertical wheel slowly rotating within a

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constant temperature air bath maintained at 35° C. Following a period of agitation and tempering of the salt solutions, the refractive index was determined at the temperature of the air bath; all refractive index determinations required throughout the course of this study were made at this temperature.

(B) An excess of lactose was added to each solution and agitation at 35° C. resumed. At intervals of 24 hours the bottles were removed from the agitator and held in a stationary position in the air bath until the suspended undissolved lactose had settled. The refractive index was then determined; this determination served to disclose the amount of lactose which had dissolved during the 24-hour period. The method used to calculate the amount of lactose dissolved in the salt solutions is explained in section (C). A comparison of the values obtained on consecutive days indicated clearly when equilibrium had been reached, at which time further agitation was discontinued and a final refractive index determination made on the equilibrated solution free from suspended lactose. The concentration of lactose in at least one of the graduated series of each salt solution was then checked by other methods. The iodometric method of Kline and Acree (12), further studied and modified by Miller (13), was found useful where copper reduction methods were inapplicable.

(C) Standardized salt solutions containing known amounts of lactose were prepared and their refractive indices determined in the same manner as for the solutions of unknown lactose concentration. By employing these values as a basis of reference, the lactose concentration in the equilibrated solutions may be determined by interpolation or graphic means; the graphic method was used in these studies. Obviously the results will be in error if any salt has been removed from solution. In view of this possibility, the results were checked at strategic points by determining the lactose and/or salt concentration by other methods. For illustration, in the case of the calcium-halides which potentially form calcium halide-lactose complexes, calcium determinations were made in addition to the refractive index readings.

In preparing the standard salt solutions containing known amounts of lactose, it is necessary to prepare at least one solution at each salt concentration in which the lactose concentration is equal to or greater than the equilibrium value. In most cases this was readily accomplished by raising the temperature above 35° C. to effect solution, cooling at 35° C. and determining the refractive index before crystallization. Usually no difficulty was encountered because the solutions remained supersaturated for a considerable time. The refractive index determinations were made with an Abbé type instrument.

The results obtained with twenty-four salts are shown in table 1. The influence of certain sodium, calcium, and magnesium salts on the solubility

of lactose is shown graphically in charts 1 and 2, respectively. It is clearly evident that the salts investigated differ widely in their abilities to influence the solubility of lactose in water. The ions arranged in order of their effectiveness (based upon a 25 per cent salt concentration) in increasing the solu-

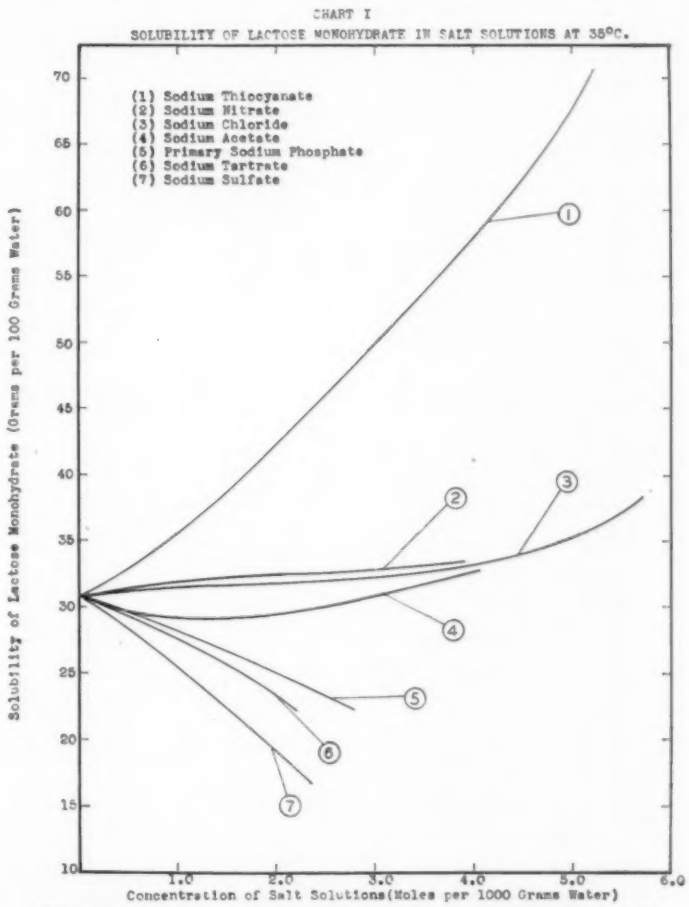

CHART 1. Solubility of lactose monohydrate in salt solutions at 35° C.

bility of lactose show the following sequence for the anions: thiocyanate, iodide, nitrite, bromide, chloride, nitrate, acetate, tartrate, dihydrogen phosphate, and sulphate. It is probable that the comparisons are of greater value when made on equimolar concentrations; such comparative values are graphically shown in charts 1 and 2. The order of effectiveness

of the cations appears to fall in approximately the following sequence: potassium, calcium, sodium, and magnesium.

It is of considerable interest to note that the sequence of the anion series conforms essentially to the series of ions compiled by Cooper (2) based

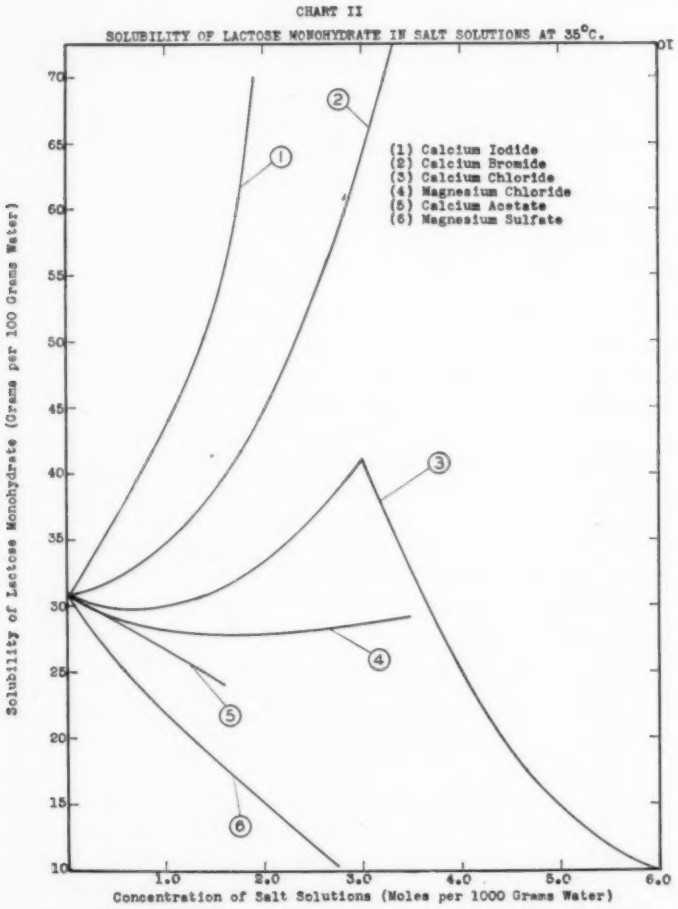

CHART 2. Solubility of lactose monohydrate in salt solutions at 35° C.

upon a calculation of the free energy of formation of the ions from their elements. His calculations place the common anions in the following order: cyanide, hydrosulphide, bromate, thiocyanate, chlorate, nitrite, perchlorate, iodide, cyanate, bromide, nitrate, chloride, iodate, fluoride, acetate, sulphite, bisulphite, fumarate, oxalate, sulphate, citrate and tartrate. Cooper points

TABLE 1

Solubility of lactose monohydrate in various salt solutions at 35° C.

A—Concentration of salt solution in per cent.
B—Concentration of salt solution expressed as moles per 1000 grams water.
C—Solubility of lactose (grams lactose monohydrate per 100 grams water).

A	B	C
Sodium Chloride		
5	0.90	31.4
10	1.90	31.7
15	3.02	32.4
20	4.27	33.8
25	5.70	38.6
Primary Sodium Phosphate		
5	0.44	29.5
10	0.93	28.8
15	1.47	26.4
20	2.08	24.1
25	2.78	22.2
Sodium Acetate		
5	0.64	29.4
10	1.35	29.0
15	2.15	29.2
20	3.04	30.6
25	4.06	33.0
Barium Chloride		
5	0.25	31.4
10	0.53	32.4
15	0.85	34.2
20	1.20	36.6
25	1.60	39.5
Calcium Chloride		
5	0.47	29.9
10	1.00	29.9
15	1.59	31.2
20	2.25	35.3
25	3.00	41.0
30	3.86	26.4
40	6.01	10.3
Ammonium Thiocyanate		
5	0.69	36.1
10	1.46	41.6
15	2.32	49.1
20	3.29	55.3
25	4.38	62.6
30	5.63	73.0
35	7.08	84.8
40	8.76	98
50	13.14	143

A	B	C
Potassium Chloride		
5	0.71	32.2
10	1.49	34.5
15	2.37	36.8
20	3.35	40.9
25	4.47	44.7
Primary Potassium Phosphate		
5	0.39	30.7
10	0.82	30.5
15	1.30	30.4
20	1.84	29.4
25	2.45	28.6
Potassium Acetate		
5	0.54	30.8
10	1.13	31.5
15	1.80	33.2
20	2.55	36.8
25	3.40	41.2
Magnesium Chloride		
5	0.55	28.8
10	1.16	28.1
15	1.85	27.7
20	2.62	28.0
25	3.50	29.1
Calcium Bromide		
5	0.26	31.1
10	0.56	32.1
15	0.88	33.2
20	1.25	36.1
25	1.67	40.1
30	2.14	46.8
35	2.69	56.8
40	3.33	72.8
Potassium Nitrite		
5	0.62	32.8
10	1.31	34.9
15	2.07	37.3
20	2.94	39.4
25	3.92	42.3
30	5.04	45.6
35	6.33	49.9
40	7.83	54.8

A	B	C
Sodium Nitrate		
5	0.62	31.7
10	1.31	32.2
15	2.08	32.5
20	2.94	32.8
25	3.92	33.5
Sodium Sulfate		
5	0.37	28.7
10	0.78	26.1
15	1.24	24.1
20	1.76	20.7
25	2.35	16.6
Potassium Oxalate		
5	0.32	31.6
10	0.67	32.0
15	1.06	32.8
20	1.50	33.7
25	2.00	35.5
Magnesium Sulfate		
5	0.44	27.1
10	0.92	23.0
15	1.47	17.4
20	2.08	14.3
25	2.77	10.2
Calcium Iodide		
5	0.18	32.9
10	0.38	36.1
15	0.60	39.5
20	0.85	42.6
25	1.13	45.3
30	1.46	51.5
35	1.83	69.9
40	2.27	82.2
Sodium Tartrate		
5	0.27	29.9
10	0.57	28.9
15	0.91	27.9
20	1.29	26.3
25	1.72	25.0
30	2.21	22.6

A	B	C
Potassium Nitrate		
5	0.52	32.2
10	1.10	33.9
15	1.75	35.6
20	2.47	37.0
25	3.30	37.9
Potassium Sulfate		
2.5	0.15	31.4
5	0.30	31.4
7.5	0.47	31.2
10	0.64	31.0
12	0.78	30.6
Ammonium Chloride		
5	0.98	33.3
10	2.08	35.6
15	3.30	39.3
20	4.67	45.0
25	6.23	51.7
Calcium Acetate		
5	0.33	28.9
10	0.70	27.2
15	1.12	25.8
20	1.58	23.9
Sodium Thiocyanate		
5	0.65	34.2
10	1.37	38.0
15	2.18	42.6
20	3.08	50.1
25	4.11	58.6
30	5.28	70.9
35	6.64	84.4
40	8.22	104
50	12.33	185
Sodium Citrate		
10	0.43	27.2
20	0.97	25.2
25	1.29	24.0
30	1.66	21.7
35	2.08	20.9

out that this series conforms in general to the lyotropic or Hoffmeister series. An orderly sequence of effectiveness of the different ions on colloidal phenomena such as the peptization of proteins (6), the flocculation of either hydrophobic or hydrophilic colloids (15, 7), and swelling pressures (4) has been demonstrated; certain ions causing a predominantly "solubilizing" effect and others a "precipitating" effect.

Hoffmeister (9) has explained the action of the ions on the basis of their abilities to monopolize the water in a solution. This offers a plausible explanation for the variation in the precipitating or salting-out effect of the ions but it is wholly inadequate to account for solubilizing effects. It is known that ions in the end of the series have a dehydrating effect because they adsorb water with great avidity but it cannot explain why the ions at the beginning of the series, which are weakly hydrated, drive lactose into solution. It seems feasible to postulate that the ions at the beginning of the series combine with lactose, the resulting compounds or complexes being more soluble than the lactose itself. This hypothesis is supported by the results obtained with calcium chloride and by those obtained with calcium bromide and calcium iodide as will be shown hereinafter.

The effect of calcium chloride on the solubility of lactose is of particular significance (chart 2). It is evident that at concentrations greater than approximately 25 per cent (3 moles per 1000 grams water) the apparent solubility of lactose drops off sharply, due presumably to the formation of a compound or complex. Herrington (11) has isolated such a compound and assigned the formula: alpha lactose · $CaCl_2 \cdot 7H_2O$. This compound can be made easily as shown by the following example.

Starting with a solution of lactose · $1H_2O$, 5 lbs.; $CaCl_2 \cdot 6H_2O$, 7 lbs. 13 oz.; and water, 9 lbs. 6 oz., 5 lbs. of the pure compound were readily precipitated. By adding amounts of lactose and calcium chloride to the mother liquor equivalent to the amount of compound crystallized out, second and third yields of the crystallized compound were obtained in 4 lb. 4 oz. and 4 lb. 14 oz. quantities, respectively. It appears that the process can be continued indefinitely with practically one hundred per cent recovery of the lactose and calcium chloride in the form of the complex. The crystals can be separated from the mother liquor by filtering and washing with a solution of 80 per cent acetone and 20 per cent water. The resulting product showed 62.1 per cent lactose and 6.90 per cent calcium by analysis, which conforms to the respective calculated values of 62.2 and 6.92 for a compound, lactose · $CaCl_2 \cdot 7H_2O$.

An analogous compound, lactose · $CaBr_2 \cdot 7H_2O$, has been prepared in a similar manner. Preliminary determinations indicated that the mole ratio of calcium bromide to lactose should be at least two to one to yield crystals of the complex. Starting with a solution of lactose · $1H_2O$, 5 lbs.; $CaBr_2 \cdot 6H_2O$, 10 lbs. 8 oz.; and water, 6 lbs., 6 lbs. 3 oz. of a crystalline compound

were obtained. The product showed 53.9 per cent lactose and 6.36 per cent calcium by analysis which conforms to the calculated value of 53.9 per cent and 6 per cent, respectively, for the compound, lactose · $CaBr_2$ · $7H_2O$. By adding equivalent amounts of lactose and calcium bromide to the mother liquor 4 lbs. 13 oz. and 5 lbs. yields were obtained from the second and third crystallization, respectively. The crystals produced were exceedingly fine, slender prisms with "hip-roofed" ends apparently consisting of three faces. They were smaller and more soluble than those of the corresponding calcium chloride complex. When washed free from excess calcium bromide, drying was readily accomplished in ordinary atmosphere to about 6 per cent of free moisture; this may be removed by further drying at 70° C. The washing of the crystals is best accomplished with a solution of 80 per cent acetone and 20 per cent methyl alcohol.

In those studies concerning the solubility of lactose in calcium iodide solutions, it was revealed that the solubility increased rapidly with increasing concentrations of calcium iodide (chart 2). In a 40 per cent calcium iodide solution, about 82 parts of lactose are soluble in 100 parts of water. Greater concentrations of calcium iodide were employed in order to determine whether or not at some higher concentration a complex analogous to the lactose-calcium chloride and lactose-calcium bromide compounds might be formed. Aqueous solutions of calcium iodide were prepared in concentrations varying from 45 to 70 per cent. Lactose was added to these solutions in small increments until saturation at room temperature was reached. A small additional quantity of lactose was then added and the mixture warmed to effect complete solution. Upon cooling to room temperature crystalline precipitates appeared. Table 2 contains the tabulated observations correlating the solubility of lactose and character of the crystalline material obtained from supersaturated solutions with the concentration of the calcium iodide solutions.

TABLE 2

Approximate solubility of lactose monohydrate in calcium iodide solutions and character crystals formed in supersaturated solutions

Calcium iodide solutions	Solubility of lactose monohydrate at room temperature	Crystals formed in supersaturated solutions
per cent	*gm. per 100 gm. water*	
45	100	Alpha lactose
50	104	" "
55	120	" "
60	129	" " and compound
65	33	Lactose-calcium iodide (prisms)
70	Less than 20	" " " "

It is evident that the deposition of the compound takes place at appropriate concentrations of calcium iodide and lactose. The necessary condi-

tions for crystallization are a concentration of 65 per cent or more of calcium iodide, and lactose slightly in excess of its solubility at the existing salt concentration. Successive batches of the compound were crystallized from the same mother liquor by maintaining the calcium iodide concentration at 65 per cent or above and making further additions of lactose if crystals of the compound failed to appear on standing; likewise, the method used for the production of the other lactose-calcium halide compounds was employed, namely, that of adding equimolar quantities of halide and lactose in the amount equal to the weight of the compound removed by crystallization. Several lots of the compound have been prepared from solutions containing 200 gm. alpha lactose, 350 gm. calcium iodide, and 200 gm. water. The product showed 52.2 per cent lactose, 5.81 per cent calcium, and 36.2 per cent iodine by analysis, which conforms to the calculated values of 52.2 per cent, 5.81 per cent, and 36.8 per cent, respectively, to the constituent components of a compound, lactose · $CaI_2 \cdot 3H_2O$.

The removal of excess calcium iodide from the crystals is of primary importance in the production of a satisfactory and stable material. Iso-propanol was found to be eminently suitable for this purpose as the crystals are only sparingly soluble in it. In practice it has been found that three washings with iso-propanol followed by the same number of washings with 98 per cent ethyl alcohol produced clean crystals which could be readily dried and freed of alcohol at 70° C. in a vacuum oven.

Table 3 shows some of the physical characteristics and properties of each of the lactose-calcium halide compounds prepared according to the methods described.

TABLE 3

Certain properties of lactose-calcium halide compounds

	Lactose · $CaCl_2 \cdot 7H_2O$	Lactose · $CaBr_2 \cdot 7H_2O$	Lactose · $CaI_2 \cdot 3H_2O$
Specific rotation	+32.6	+28.3	+27.4
Melting point	86–87°	98° (softens)	180° (decomp.)
Solubility in water at 35°*	52 parts	69 parts	86 parts
Solubility in ethyl alcohol	Insoluble	Insoluble	Very slightly soluble
Solubility in ethyl ether	Insoluble	Insoluble	Insoluble

* Expressed as grams per 100 grams water.

The successful crystallization and isolation of lactose-calcium halide compounds provides evidence in support of the hypothesis that the observed marked increase in solubility of lactose in the presence of these salts is due in reality to the formation of a complex more soluble than the lactose itself. Whether similar complexes are formed with lactose and other salts which cause an apparent increase in effectiveness for maintaining lactose in solution, cannot be stated with finality on the basis of the data presented. The

evidence indicates that the separation, by differential crystallization, of such complexes as may be formed would involve definite knowledge and control of critical saturation levels of the lactose, salt and compound components of the multiple phase system.

SUMMARY

1. The solubility of lactose in solutions of twenty-four different salts has been determined. The comparative influence of the various salts places the ions in an order of arrangement conforming essentially to the series compiled by Cooper based upon free energy values, and to the Hoffmeister series.

2. The solubilizing effects noted are explained by postulating the formation of complexes or compounds which are more soluble than the lactose itself.

3. The lactose · $CaCl_2 \cdot 7H_2O$ compound previously reported has been prepared by simple means, and methods for preparing two other compounds, lactose · $CaBr_2 \cdot 7H_2O$ and lactose · $CaI_2 \cdot 3H_2O$, are described.

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SOME OBSERVATIONS ON THE ERADICATION AND CONTROL OF BANG'S DISEASE

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Research on Bang's disease has been in progress at the Storrs Agricultural Experiment Station since 1913.[1] The ground work for our present program of control was laid by Rettger, White, McAlpine, Johnson, and Chapman. Their early researches yielded several important contributions to the fundamental knowledge of the diagnosis and control of Bang's disease, involving periodic blood testing and segregation and removal of infected animals. Of special value to such a program were their observations; (1) that calves, with rare exceptions, remain resistant to an established infection to the time they approach sexual maturity, (2) that, once the infection becomes established in adult individuals, over 90 per cent remain infected, and (3) that in no herd under observation was the disease eradicated, except by a program of periodic testing and removal of the positive animals.

The earlier control experiments were limited to the University of Connecticut herd and a small selected group of private herds. In 1925 the work was extended to include several additional herds. During the past 15 years the number of herds tested annually has increased from 27 to 624, the laboratory having become the official State Laboratory for Bang's disease testing in 1931. As might be expected, expansion of the work has brought out new problems.

In recent years the experimental part of the Bang's disease project has been concerned with increasing still further the efficiency of the agglutination test, establishing the true significance of negative, suspicious, and positive reactions in different herds, determining the number of tests required to eradicate infection, determining the sources and extent of reinfection in negative herds, establishing the presence of infection in animals other than cattle, and seeking the cause of occasional abortions in Bang's disease-free herds.

THE AGGLUTINATION TEST

The agglutination test has proved to be a strong weapon against this disease. When properly carried out it detects infection in individuals in a herd with a high degree of accuracy.[2] While abortion is a common symptom

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[2] Attested to by the system of retesting the same animals repeatedly, and by the close correlation of the results of the agglutination test and of the complement fixation tests conducted on the same animals.

of Bang's disease, some infected cows do not abort and some of those which do may eventually produce full-term calves. Moreover, abortions occasionally result from causes other than Bang's disease. These facts make the agglutination method all the more important in the diagnosis of Bang's disease.

A significant factor that must be kept in mind in the practical use of the agglutination test is that a period of from one to six weeks, and occasionally longer, is required between the time *Brucella abortus* enters the body of a newly infected animal and the time the host becomes positive to the test. Therefore a negative reaction given by an animal in a herd undergoing increasing infection should not be regarded as conclusive evidence that the animal is free from infection at the time.

Convincing evidence that a positive agglutination reaction is a reliable indication of infection with *Br. abortus* is found in the fact that herds from which reacting animals were removed have remained free from positive reactors in repeated tests over periods as long as 13 years. If false positive reactors had been at all common these observations would not have been possible. Furthermore, repeated tests on the same positive adult animal over periods of years have shown them to be consistently positive, except for an occasional reactor that returns to negative.

The belief that an infected animal in advanced gestation becomes temporarily negative to the agglutination test seems to be without foundation, as has been shown by repeated tests on positive animals. However, from a practical standpoint there is reason to doubt the value of a negative test on animals near parturition time in known infected or untested herds. One reason is that animals in the later stages of gestation are particularly susceptible to infection and may become infected at this time and calve between the time infection occurs and the time the blood test becomes positive.

State and federal research workers have cooperated in the past few years in improving and standardizing the tube agglutination test. The standard tube test, when conducted by experienced persons and when made according to the accepted standard, yields remarkably consistent results, as the following pages will show.

Consistency of Reactions in Repeated Tests. In the present Connecticut system, herds are frequently given a preliminary test to determine the number of replacements needed before subjecting the herd to a federal test. The second or federal test is usually made from one to five months after the first.

Of 938 animals in 31 infected herds, 206 reacted positively in the first test. In the second test 196 were positive, 6 suspicious and 4 negative. There was 95 per cent agreement. Available evidence indicates that the four animals which changed from positive to negative did so because they recovered from a light infection. Vaccination with dead or attenuated *Br. abortus* cells may also cause a temporary positive or suspicious reaction.

Of 665 animals in 19 negative herds, none reacted positively on retest; one gave a suspicious reaction and the remainder were negative. In this instance the agreement was 99.85 per cent.

Recently blood from 15 suspicious and positive animals was tested in four official laboratories. The results obtained are of interest because they confirm previous conclusions that there is little disagreement between responsible laboratories which employ the standard tube test. Ten of the 15 samples were positive in all four laboratories. The remaining five were recorded as suspicious by three of the four laboratories, while the fourth reported three samples as suspicious and two as positive.

THE SUSPICIOUS REACTOR[3]

The very nature of all serological tests, as well as allergic reactions like the tuberculin test, is such that suspicious (partial) reactions must occur. They represent stages of transition from negative to positive in which the infection has been too recent or slow in establishing itself to produce sufficient agglutinins or sensitization to give a positive reaction to the test. Furthermore, some animals receive a light infection which is destroyed by the animal's defensive mechanism and hence give a temporary suspicious reaction. The occasional animal that changes from positive to negative must likewise pass through an intermediate or suspicious stage.

The proportion of suspicious reactors under our observation which gave positive reactions in subsequent tests varied materially from herd to herd.

In herds which had been negative in previous tests and which possessed suspicious reactors later, the average number of suspicious animals that became positive on subsequent tests was 16.6 per cent. In infected herds having a slow spread of infection the proportion was 26 per cent, and in herds in which there was rapid spread 63.6 per cent became positive. The average incidence of suspicious reactions in a group of infected herds was about three times as great as in a group of herds that were negative as such in the previous test. This observation indicates that in the infected herds a majority of suspicious reactions were caused by *Br. abortus*. About half of these became negative on subsequent tests.

Duration of Suspicious Reactions. In general, animals giving a suspicious reaction may be expected to give a stronger reaction within 10 to 14 days, if the suspicious reaction is caused by an infection that becomes established; or a weaker reaction if the animal overcomes the infection, or if the suspicious reaction is not caused by *Br. abortus*. In rare instances an animal may give a suspicious reaction over a period of years. Three such animals have been observed by us.

[3] On the basis of extensive studies by numerous experiment stations and the Bureau of Animal Industry, a suspicious reaction may be defined as one in which agglutination is partial or complete in the 1 to 50 dilution of serum and negative or partial in the 1 to 100 dilution.

SYNOPSIS OF SEROLOGICAL TESTS FOR BANG'S DISEASE CONDUCTED AT THE STORRS LABORATORY

From July 1, 1925, to July 1, 1938, the number of samples tested annually increased from 2,373 to 42,700; the number of individual animals from 992 to 16,539; the number of herds from 27 to 624, and the number of herds passing one or more negative tests from 4 to 473. The number of herds passing two or more clean successive tests during the past fiscal year was 285.

The average number of animals giving positive reactions in their initial tests during the period 1925–1938 constituted 18.4 per cent for all herds, and 22.6 per cent for 686 herds which contained one or more positive animals at the time of the first test. When half of the suspiciously reacting animals are included, the results indicate that in Connecticut about 25 per cent of the animals in herds tested for the first time are infected.

PROBLEMS IN ERADICATION

In the early work on Bang's disease at the Storrs station attempts were made to control the disease in the college herd by sanitation and segregation of positive animals, and gradually replacing them with Brucella-free individuals. Success attended these efforts for about three years, at the end of which several heifers reacted to the blood test and a new wave of Brucella infection ran through the barn. On the basis of this observation and of results obtained in other herds, the conclusion was reached that segregation of positive animals in the same barn or on the same premises, or on different premises having the same personnel, is usually inadequate to prevent further infection, and that early and complete removal of all reactors is an absolute essential. Through cooperation with state and federal authorities, this policy has been adopted and is now carried out in Bang's disease control work on an increasingly large scale.

Number of Tests Required for Eradication. In a large majority of herds under observation the number of tests necessary to eradicate infection under the plan which requires immediate disposal of positive reactors was surprisingly small, as the following figures on 149 different herds show.

Herds	requiring	from	1	to 2	tests—64.5%
"	"	"	3	to 4	" —22.7%
"	"	more	than	4	" —12.7%

About 13 per cent of the herds that were found to be infected in the initial tests required more than the usual number of tests. In these the rate of spread of infection was rapid. Indeed, experience has shown that eradication is accomplished much more rapidly after, rather than during, the height of a so-called "abortion storm."

Results obtained during the past few years show that in the majority of

infected herds tests made at frequent intervals (30 days between tests) are more effective in eradicating Bang's disease than tests made at longer intervals; and that the incidence of initial infection in any given herd does not necessarily bear any definite relation to the number of tests required to eradicate the infection.

Possible Ways of Spread. Complete solution of the problem of preventing the spread of infection requires further knowledge of the ways in which *Br. abortus* leaves the body of an infected animal, and by which it gains entrance and establishes itself in hitherto uninfected individuals.

The organism may leave the body of an infected cow in the milk and in the discharge from the genital tract especially following calving. The placenta and fetus appear to be particularly dangerous sources of infection. Whether in the milk or uterine discharges, the infectious organism may pass to other animals in one or more of the following ways: By direct contact with the infected cow, afterbirth or fetus; through contamination of the floor and eventually the feed and water; by the infectious material becoming lodged on the tail and brushed across the face, especially the eyes; by the use of bulls on infected and noninfected heifers and cows; by being carried to the feed manger on the shoes of persons who have entered isolation stalls which house infected cows at calving time; and by being carried to the teats of cows on the hands of milkers or on the teat cups of the milking machine, and then gaining entrance through the teat canal or injured skin of the teat.

The following sanitary measures should aid materially in preventing the spread of the disease in an infected herd:

1. Prompt isolation of pregnant cows at the first indication of parturition, and of all cows having an abnormal discharge from the genital tract. Calving animals should be kept in isolation until they have passed a negative test after calving. Pans of disinfectant should be placed at the entrance of the stalls occupied by isolated cows, and used freely by attendants.

2. Daily washing of the flanks, vulva and tail with a strong soap solution, followed by treatment with a disinfectant solution such as 1 per cent Liquor Cresolis Compositus or a 0.5 per cent solution of Phenolor (Squibb).

3. The rinsing of milkers' hands or teat cups of the milking machine with hypochlorite solution, containing about 300 parts per million of active chlorine, between individual milkings.

4. Blood testing at intervals of 30 days.

5. Immediate removal of both suspicious and positive reactors.

MAINTENANCE OF NEGATIVE HERDS

Eradication of Bang's disease from a given herd is only part of an effective control program. Once eradication has been accomplished the herd must be protected against new infection.

As long as infected herds exist in a given community there is a possibility

of reinfection from contact with infected animals on adjoining farms as the result of members of either herd becoming unconfined. However, the danger of reinfection from outside sources may be reduced to a very low minimum if owners will familiarize themselves with the basic principles of the agglutination test, ways in which new infection may gain entrance, and the present official system of eradication and control.

The incidence and possible circumstances attending reinfection in herds which have passed several negative tests have been made objects of special study in herds which have been under observation for periods of from 2 to 13 years.

Incidence of Infection in Reinfected Herds. Of 218 herds under observation for periods of from 2 to 13 years following initial negative tests, 67 became reinfected. In 26, or 38.8 per cent of the reinfected herds, the number of new reactors was only one; in 52, or 77.6 per cent, the number was five or less, and in 9, or 13.5 per cent, it was 10 or more. When we consider the high percentage of infected herds in Connecticut and the fact that during all of these years the control work was conducted on a more or less experimental basis, the number of "breaks" was not at all discouraging. Furthermore, new infection was limited to one or two animals in about half of the reinfected herds which were tested at regular intervals of six months.

Number of Tests Required to Eradicate New Infection. Of 65 herds which had one or more new reactors, 29 were found to be entirely negative to the first test following detection and removal of the newly infected animal or animals; nine additional herds were negative in the second herd test, seven in the third, seven in the fourth, and two in the fifth test. Eight herds required from six to ten tests, and three more than ten.

Probable Sources of Reinfection. An effort was made to determine the probable source of reinfection in 39 herds which had been negative to the blood test. Information obtained indicated that the most common cause of reinfection was association with infected cattle, as, for example, new additions to the herd and neighbors' animals with which contact was made through inadequate or broken pasture barriers.

The majority of additions that were responsible for reinfection were recently infected cows which came from untested or infected herds and which were negative at the time of purchase.

In two herds bulls which had been negative when brought in subsequently reacted positively, along with cows which they had served. In another herd a positive bull was bred to negative cows, which subsequently reacted to the blood test, as did several others in the herd.

Two herds were reinfected after a cow in estrum had broken through a barrier and mingled with infected cattle, and two were reinfected after cows from outside herds had broken into the enclosure of negative cattle.

Pasturing heifers from negative sources with those from untested herds accounted for two "breaks."

Available evidence indicated that two "breaks" were caused by association with infected horses, and one by the presence of infected swine on the premises.

It appeared that in 11 instances infection was carried into the dairy barn by persons coming directly from infected herds.

No information was obtained on eight herds.

BR. ABORTUS INFECTION IN ANIMALS OTHER THAN CATTLE

Nine of 104 blood samples from swine and 13 of 100 samples from horses reacted positively to the test. All of 162 samples from 20 herds of goats, two from deer, two from cats, and one from a dog were negative to the agglutination test for infection with *Br. abortus*.

ABORTIONS IN BANG'S DISEASE-FREE HERDS

Occasional abortions are known to occur in herds which have passed several negative tests for Bang's disease. Under such conditions the question naturally arises whether the abortion resulted from Bang's disease or some other cause. Since 1932 bacteriological examinations have been made on fetuses and placental material from 36 aborting cows in 24 herds which were free from Bang's disease, as indicated by two or more previous herd tests. The suspected material was examined for the presence of *Br. abortus* by cultural methods and by guinea pig inoculation. Bacto Tryptose agar prepared with 1 to 700,000 gentian violet, liver infusion agar, and blood agar plates were inoculated with the suspected material. The inoculated media were incubated at 37° C. in an atmosphere which contained 5 per cent carbon dioxide. The plates were examined after 3 and 5 days. Cultures were prepared from Brucella-like colonies and examined for morphological and cultural characteristics and for evidence of a serological relation to *Br. abortus*. Isolations for study were also made from other types of colonies which occurred either in significant numbers or resembled those of known pathogenic bacteria.

Br. abortus was not obtained from any of the 36 specimens from herds which had previously passed two or more negative tests, and the herds involved were free from positive reactors on subsequent tests.

Bacteriological tests made on a fetus from an animal in a herd which had passed only one negative herd test yielded *Br. abortus*. In this instance the cow which aborted gave a negative blood test two weeks previous to the abortion and a positive reaction when tested one week after the abortion. The results show that the aborting animal was recently infected, and that the abortion occurred during the period between the time of infection and the development of a positive reaction. The herd in question is a good example of the importance of prompt isolation of animals which abort and of not

returning such animals to the herd until they pass a negative blood test made from one to two weeks after parturition.

Bacteriological tests on the 36 specimens of fetuses and placental material in which *Br. abortus* was not present revealed streptococci distinct from *Streptococcus agalactiae* in 8 specimens; diphtheroids, the majority of which were identified as *Corynebacterium pyogenes,* were obtained from 8, hemolytic coagulase positive staphylococci from 6, *Pseudomonas pyocyanea* from 1, a monilia-like form from 1, and coliform organisms from 2. No bacteria were obtained from 10 fetuses.

Some recent observations indicate that the diphtheroids and staphylococci obtained from aborted fetuses in Bang's disease-free herds are identical with similar organisms obtained from pus from the uteri of several cows affected with metritis. Consequently, it appears that uterine infection with bovine pyogenic bacteria may result in either sterility as a result of severe metritis or, if pregnancy occurs, in abortion. Abortion associated with pyogenic bacteria is not limited to Bang's disease-free herds. The availability of herds free from Bang's disease greatly facilitates studies on bovine genital diseases due to causes other than *Br. abortus.*

SUMMARY

During the period 1925–1939, the number of cows' blood samples tested annually increased from 2,373 to 42,700; the number of herds from 27 to 624; and the number of herds passing one or more negative tests from 4 to 473.

The average incidence of infection observed in infected herds at the time of the initial tests was found to be about 25 per cent.

The average number of suspicious reactors that became positive was 16.6 per cent in herds which were negative in the preceding test; 26 per cent in herds in which spread of infection was slow; and 63.6 per cent in herds in which spread of infection was rapid.

Of 149 infected herds, 64.5 per cent required from one to two tests for eradication; 22.7 per cent required from three to four, and 12.7 per cent, more than four tests.

The principal source of reinfection was found to be association with infected animals, either as the result of adding cows or bulls from untested or infected herds, or of animals breaking into or out of pasture. Association with infected horses or swine accounted for several "breaks," and in some instances available evidence indicated that infection resulted when people went directly from infected to negative herds.

Bacteriological examinations of fetuses and placental material obtained from 36 aborting cows in 24 herds which were free from Bang's disease, as shown by the standard tube agglutination test, were all negative for *Brucella abortus.*

In general, available information indicated that "breaks" are preventable. In about half of the reinfected herds, regular six-month retests detected new infection before it had a chance to spread to more than one or two animals.

At the present time many negative herds exist on farms which adjoin farms on which there are untested or known infected herds. As the eradication program progresses and sources of new infection are eliminated the number of "breaks" from these sources may be expected to decrease materially.

THE VITAMIN A REQUIREMENTS OF DAIRY COWS FOR THE PRODUCTION OF BUTTERFAT OF HIGH VITAMIN A VALUE. I. ARTIFICIALLY DRIED ALFALFA HAY (CAROTENE)[1]

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Numerous investigations (1–8) have shown that the vitamin A potency of milk fat is dependent upon the diet fed the cow. Several investigators (9–13) have also studied the vitamin A requirements of cattle with respect to the well being of the animal itself. Comparatively few investigations, however, have been conducted to determine the vitamin A requirements of dairy cattle for the production of milk fat of high vitamin A activity. Fraps, Copeland and Treichler (14) observed that when lactating cows were restricted to 17,000 vitamin A units daily from yellow corn the vitamin A potency of the milk fat decreased from 38 to 16 units in four weeks. These workers also found that feeding 116,000 vitamin A units daily failed to maintain the vitamin A potency of the milk fat. Later the same investigators (15) found that 340,000 daily unit intake failed to maintain the vitamin A potency of the butterfat and estimated that from 750,000 to 1,400,000 Sherman-Munsel units were needed daily by cows to produce butterfat of high vitamin A value. Atkeson and associates (16) concluded that butterfat secreted by dairy cows fed a ration containing 1,000,000 international units of carotene daily was typical of grass produced butter. Increasing the carotene intake to approximately 6,000,000 units daily resulted in practically no change in the carotene and vitamin A content of the butter.

EXPERIMENTAL

The general plan of procedure in these experiments has been to decrease the vitamin A potency of the milk fat to a low level by feeding the cows vitamin A deficient diets, and then determine the number of vitamin A units required daily by the cows to bring the vitamin potency of the milk fat back to a high level. The vitamin A deficient ration was composed of beet pulp, and a grain mixture of white corn, oats and linseed oil meal. The principal source of vitamin A in the repletion rations was artificially dried alfalfa hay. Two separate experiments similar in nature have been completed.

EXPERIMENT I

Two Guernsey cows were used in this feeding experiment. They were

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in the early stage of lactation at the beginning of the feeding trials and continued in normal milk flow throughout the experiment. The cows were fed the vitamin A deficient diet until the vitamin A potency of the milk fat had dropped to a low level (12 units). At this point, one, two, three, five, eight and twelve pounds of artificially dried alfalfa hay of known vitamin A value were added to the ration in successive 21 day feeding trials. Twenty-one

TABLE 1

Showing the vitamin A requirements of dairy cows when dehydrated alfalfa hay (carotene) was the source of vitamin A activity of the ration (1935–1936)

Period No.	Vitamin A supplement*		Vitamin A butter (units per gram)
	A.D. alfalfa hay (lb. daily)	Unit intake (000)	
1	None	None	12
2	1.0	75	12
3	2.0	150	12
4	3.0	225	11
5	5.0	375	19
6	8.0	600	31
7	12.0	900	30

* Ration consisted of beet pulp and a grain mixture consisting of 400 lb. white corn, 200 lb. oats, and 150 lb. linseed oil meal.

day feeding trials were used because previous studies (17) had shown that the major change in the vitamin A activity of milk fat resulting from a change in diet takes place during the first fifteen days.

Representative samples of milk were collected from each cow during the last four milkings of each period, the cream separated and churned into butter. Each sample of butter was then subjected to biological assays for vitamin A potency. The results of these assays are expressed in Sherman and Munsel vitamin A units (18).

TABLE 2

Showing the vitamin A requirements of dairy cows when dehydrated alfalfa hay (carotene) was the source of vitamin A activity of the ration (1936–1937)

Period No.	Vitamin A supplement		Vitamin A butter (units per gram)
	A.D. alfalfa hay (lb. daily)	Unit intake (000)	
1*	(check)	Not determined	33
2†	None	None	14
3†	1.0	67	15
4†	3.0	201	15
5†	5.0	355	25
6†	8.0	536	29
7†	12.0	804	31

* Ration consisted of alfalfa hay, silage and a grain mixture consisting of 400 lb. yellow corn, 200 lb. oats, and 100 lb. linseed oil meal.

† Ration consisted of beet pulp and a grain mixture consisting of 400 lb. white corn, 200 lb. oats, and 100 lb. linseed oil meal.

EXPERIMENT II

Two Guernsey cows were used in the feeding experiments of the second trial which was essentially a duplication of the first trial. These cows were also in the early stage of lactation at the beginning of the experiments and continued in normal production throughout the tests.

The feeding schedule and the biological assays of the hays and butterfat for the two experiments are shown in tables 1 and 2 and figure 1.

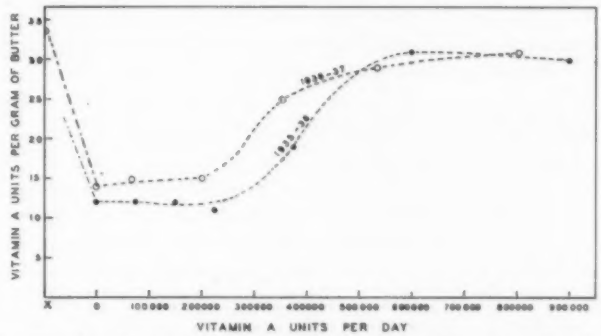

FIG. 1. The vitamin A potency of the butters produced by cows when fed different levels of vitamin A (dehydrated alfalfa hay).

DISCUSSION

In these experiments, the criterion for the measurement of the vitamin A requirements of dairy cows for the secretion of milk fat with maximum vitamin A value is based upon the supposition that cows are not able to secrete butterfat of maximum vitamin A value until the optimum requirements for maintenance and production have been satisfied. Since the vitamin A value of butterfat secreted by the cow is dependent on the ration fed the cow, it is apparent that whenever cows secrete butterfat of low vitamin A value, this is indication of an inadequate supply of available vitamin A in the ration. Furthermore, if more potent butterfat is produced upon increasing the vitamin A intake, this would also indicate that the vitamin supply had been inadequate. Only when further additions to the rations give no further response in the potency of the butter, is there any assurance that a point of saturation has been reached. Thus, the minimum vitamin A potency of the ration which will produce the maximum effect upon the milk fat secreted should prove to be the minimum vitamin A requirement of the cow for the secretion of milk fat of high vitamin A value.

As shown in tables 1 and 2 and in figure 1, the vitamin A value of the milk fat secreted by the cows was reduced to relatively low levels by feeding a ration deficient in vitamin A. In successive feeding periods, the addition of various amounts of vitamin A (carotene) up to 225,000 units per day

did not result in any appreciable repletion but was capable only of maintaining a vitamin A level equivalent to that of the preliminary depletion period. Not until a daily intake of over 300,000 units was introduced into the ration was a significant increase apparent in vitamin A potency of the milk fat. This repletion continued with successive increases of vitamin A in the ration until a saturation was reached at approximately 550,000 units per day as evidenced by the restoration of the high potency of the milk fat. Additional vitamin A units in the ration failed to produce a significant increase in the milk fat. In these studies the vitamin A requirements of the cows to produce milk of high vitamin A value is somewhat less than that suggested by Fraps and co-workers (15).

In these experiments, the source of vitamin A was the carotene in artificially dried alfalfa hay. The alfalfa was harvested in the tenth-bloom stage and was of excellent quality. The vitamin A values of these hays were determined by biological assays. Although there was some difference in the vitamin values of the hays, there was a close correlation between the vitamin A intake and the vitamin A value of milk fat secreted in the two experiments. This would indicate that the utilization of the carotene in the hays of these experiments was approximately the same. However, it is to be recognized that the carotenes in various feeds or even vitamin A per se, may be utilized with different degrees of efficiency. The type of hay, the fertility of the soil, the maturity of the plants, the methods of preservation may influence the availability of the vitamin.

SUMMARY

1. Two feeding experiments have been completed to determine the minimum vitamin A requirements of dairy cows for the production of butter with maximum vitamin A value.

2. Artificially dried alfalfa hay was used as the source of vitamin A (carotene).

3. Under the conditions of these experiments, it was found that dairy cows required approximately 550,000 vitamin A units daily to restore the vitamin A potency of the milk fat to its highest value.

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THE THIRTY-FIFTH ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLTZ
Secretary-Treasurer

The American Dairy Science Association was called to order by President E. S. Guthrie, in the Purdue Memorial Union Building at Purdue University, on Tuesday, June 25, at 9:30 A.M. for the thirty-fifth annual meeting.

The program printed in the June issue of the JOURNAL OF DAIRY SCIENCE was prepared by the Program Committee. The June issue also contains the abstracts of the papers presented.

Dr. E. C. Elliott, President of Purdue University, was introduced by Past President H. W. Gregory, and delivered the address of welcome. President Guthrie then gave the following response:

"We thank you, President Elliott, for your cordial welcome. Already we are enjoying the happy spirit of hospitality of your campus. The men and women, who have charge of the buildings, seem to know exactly how to make us comfortable. We have known your dairy staff as enthusiastic colleagues in dairy science. We are now recognizing in them the ideal qualities of hosts, and we admire the splendid assistance of their wives.

"This is the second year that our Association has held its annual convention in Indiana. The first one was in Indianapolis at the time of the National Dairy Show in 1925. We are happy to return,—this time to enjoy the fine accommodations of your facilities here at Purdue University."

President Guthrie then introduced Dr. Paul F. Sharp, of Cornell University, who responded by a most interesting discussion of the milk fat globule.

THE MILK FAT GLOBULE

PAUL F. SHARP
Cornell University, Ithaca, New York

President Guthrie, President Elliott, members of the American Dairy Science Association, and ladies:

I have a very small but to me a very interesting subject. The fat in milk is present in the form of little spheres about one ten-thousandth of an inch in diameter. The small size of the subject does not preclude, however, the use of large, perhaps incomprehensible numbers. In the beginning I wish to tell you that I am full of my subject as a speaker should be, having had 15 hundred billion fat globules for breakfast. In other words, I drank a glass of milk. If fat globules were dollars, 12 cc. would pay the national debt as it stood two weeks ago. Women can count money faster than men and it is estimated that a woman can count one million one dollar bills in a

month. If the fat globules were dollar bills it would take 1000 women 321 years to count the fat globules in a quart of milk. There are more fat globules in 1 cc. of milk than there are people living on the earth today. Cows in the United States produce each year 1.67×10^{23} fat globules. The Department of Agriculture and Dr. Campbell have not yet undertaken the task of supplying data on milk produced by other sources. If all of the fat in the globules of cows milk produced each year in the United States were brought together in one mass it would yield a cube 137 yards each way. Small as the fat globules are, and tremendous as are their numbers, yet to visualize relative magnitudes, it is interesting to note that there are as many atoms in 3.3 grams of carbon as there are fat globules produced in cows milk in the United States each year.

If the fat globules in one quart of Guernsey milk were laid end to end they would form an invisible thread of beads 5860 miles long. The thread would be 20 miles shorter if Holstein milk were used.

The fat globules in a quart of Guernsey milk have a total surface of 1050 square feet, and of Holstein milk 880 square feet. A quart of milk contains about 40 cc. of fat. If one were required to paint the surfaces of the fat globules in one quart of milk, one gallon of paint would not be sufficient. The cow is, however, a much more efficient painter; she coats the surface of these fat globules and uses only 0.25 gram of material, or an amount equivalent to about 5 drops of the kind of coating the cow puts on them.

It may be of interest to students of milk secretion that on the average a quart of Guernsey milk contains about the same number of fat globules as does a quart of Holstein milk. This indicates that the milks differ not so much in number of fat globules secreted as in their size.

Composition of the fat

Milk fat is rather unique among natural fats in that the glycerides present are esters formed from such a variety of fatty acids. Milk fat contains from 8 to 14 different fatty acids fastened to glycerine in various possible combinations of one, two or three acids. Working out the various combinations of three acid molecules fastened to one glycerine molecule, several hundred different kinds of molecules are possible in milk fat. No one knows how many different kinds of molecules are actually present. The average fat globule contains 10 billion molecules of fat.

The melting point of the fat is often reported as a characteristic physical property, and it is defined as the temperature at which the last crystal of fat disappears upon warming. Actually, the rate of warming exerts some influence upon this melting point. However, the definition would also hold for the formation of a solution. If we took a mixture of different crystalline sugars and water and warmed the mixture, we would find a temperature at which the last crystal of some one of the sugars would disappear. Ordi-

narily, this would not be a true melting point but would be called the temperature of solution or perhaps of saturation. Often it is not appreciated that the so-called melting point of milk fat is similar to the solution of the hypothetical mixture of sugars. Fat fractions can be separated from milk fat which do not melt until a temperature of 60–70° C. is attained, while those same materials when present in their normal milk fat environment disappear as solid phase when a temperature of 35° C. is reached. Also fractions can be separated which do not crystallize after holding for months at 0° C. Thus this so-called melting point of milk fat is the temperature at which the most insoluble fat fraction dissolves in the solution of glycerides.

Many factors affect the relative proportions of fatty acids present in milk fat. The most commonly mentioned factors are the feeding of oil products which tend to increase the proportion of oleic acid and yield a softer milk fat. Dry feeds are more common in winter than in summer and less oleic acid is usually present in winter fat than in summer fat. Starvation has been shown to increase greatly the oleic acid content of milk fat.

The so-called color of milk fat is of considerable commercial importance. The color is not due to colored glycerides but to the presence of carotene dissolved in the fat. Carotene is the precursor of vitamin A and from the nutritional standpoint its presence or the presence of vitamin A in the fat is very desirable. In general, yellow market milk is preferred. It has a sales appeal because yellow color has been associated with high fat content. The yellow color of whole milk is due to three factors—the amount of carotene pigment in the fat globules, the size of the fat globules and the amount of riboflavin in the water phase. With the same amount of carotene in the fat and the same amount of fat in the milk, milk containing the large fat globules will appear more yellow to the eye than milk containing small fat globules. Definite statistical breed differences in the color of milk fat have been demonstrated; the Guernsey milk fat tends to contain more carotene than the Holstein milk fat whereas, Holstein milk fat contains more preformed colorless vitamin A. However, no milk fat would be colored yellow unless carotene were supplied to the cow in the feed.

Under one set of conditions, at least, the yellow color in the milk fat is considered objectionable. Consumers seem to prefer a butter of average yellow color. If the yellow color is too intense, as occurs particularly in butter made from Jersey and Guernsey milk when the cows are on rich spring and summer pasture, consumers object because they think the butter is artificially colored. In certain markets sale of this butter is difficult and ways of decolorizing it or of destroying the carotene have actually been considered.

Physical state of the fat

The great variety of fat molecules present in the globules, as well as many other related observations, indicate the desirability of specific knowledge as

to the physical state of the fat in the fat globules under a variety of conditions. Information as to the physical state of the fat when the temperature of pure fat in a beaker is altered does not give this desired information, for the reason that great lags occur in the adjustment of the physical state of the fat to a new environmental condition. For example, if liquid fat is being cooled the presence of a few crystals in the beaker by seeding induces the crystallization of fat throughout the whole beaker. When fat is present as fat globules the appearance of a crystal in one fat globule exerts no seeding effect on the fat in any other globule. Consequently the lag in adjustment of the physical state of the fat when suspended as fat globules is very much greater than the lag in adjustment of the physical state of the fat when present in a beaker.

The information as to the actual physical state of the fat in the globules must be obtained by indirect methods. The two most successful methods are change in specific heat and change in specific volume. Studies of this type indicate that at least four hours must pass before cooled fat even approaches an equilibrium state. The experiments also indicate that it may take months for the final adjustment to be reached. Within the solidifying zone it is not sufficient to state the temperatures of milk and cream in order to define their properties. The previous temperature-time history through which these products have passed prior to reaching the temperature exerts a profound influence on the properties of the products. A few of the numerous illustrations of this effect will be mentioned.

Lactometer readings

The density or lactometer reading of milk used in conjunction with the fat content for the calculation of total solids is carried out at a standard temperature of 60° F. (15° C.). It may make a difference of 1 or more lactometer degrees (0.001 in specific gravity) whether the milk was cold milk warmed to 60° or heated milk cooled to 60°. Because the lag in adjustment of the physical state of the fat is greatest near 60° F. a more unsatisfactory temperature for making this density reading could not have been found. If the milk is previously warmed to about 45° C. (113° F.) and then cooled to 30° C. and the density determinations made at 30° C. (86° F.) the fat will be present in only one physical state—the liquid state. We are only certain of the density of fat when it is in the liquid state.

Centrifugal cream separation

Aside from the mechanical construction of the separator and the rate of flow of milk through it, the properties of the milk affect the movement of the fat globules through the plasma phase under centrifugal force. These properties are: first, the viscosity which decreases as the temperature increases; second, the difference in density between the fat globules and the plasma phase which increases with temperature; and third, the size of the fat glob-

ules which increases on warming and decreases on cooling. These factors are not linear functions of temperature. The relationship of these factors is such that increasing the temperature in the low temperature range—that is, between 0 and 25–30° C.—increased the effective force of separation by about 33 per cent for each 5° C. increase in temperature. In the range from 40–45° C. on up, the effective force is increased by only about 10 per cent. Thus, there is a sharp bend in the curve indicating that warming is markedly beneficial in the separation of milk up to a temperature in the neighborhood of 40° C. or 100° F.

In late years, there has been a tendency to use lower and lower temperatures of separation, because more viscous cream is obtained. The better body probably results from the absorption of the agglutinin on the fat globules in the low temperature range. The fat lost in the skimmilk, when milk is separated at an intermediate temperature, in the neighborhood of 70–80° F., is influenced by the previous temperature history of the milk. The fat loss in the skimmilk is less on milk which was previously warmed and cooled to this temperature for separation because the fat will be in a more liquid state, thus maintaining a greater difference in density between the fat and the plasma and because the fat globules in the liquid state are larger than the fat globules in the solid state. The conditions would be reversed in the case of cold milk warmed to the same temperature for separation.

Another interesting observation relating to temperature of separation was found as a result of preheating milk to a series of temperatures previous to separation at 100° F. Samples of milk were pasteurized for 30 minutes at temperatures up to 176° F. (80° C.). These samples were then cooled to 100° F. and the milk was separated immediately. The fat content of the cream increased progressively as the temperature of pasteurization increased.

Churning

The physical state of the fat exerts a profound influence upon churning. Normal churning occurs only when the fat in the fat globules is in the part solid, part liquid state. At low temperatures (50° F. or below) the fat is essentially solid and churning does not occur. At temperatures above 100° F. the fat is almost completely liquid and again churning does not occur. The churning time between these two temperature zones depends upon the relative proportions of solid and liquid fat and whether or not liquid fat globules are cooled into the churning zone or solid fat globules are warmed into the churning zone. The shortest churning time is not obtained at the same temperature when approached from these two different directions. It occurs at lower temperatures for the previously liquid fat and at higher temperatures for the previously solid fat. The properties of the butter and the fat lost in the buttermilk are also influenced by the proportion of solid and liquid fat at churning time.

Incidentally, the presence of casein in the cream exerts a profound influence on the churning time. If the casein is in a precipitated state, as in sour cream or cream to which rennet has been added, the churning time is relatively short as compared with that for cream in which the casein is hydrated and highly dispersed. Another interesting point is shown by the effect of acidity on the churning of washed cream. Within the practical range, the more acid the normal cream the shorter the churning time, but in the case of washed cream, that is cream in which the plasma phase has been replaced by water and thus casein is absent and only the materials on the surface of the fat globules remain; the more acid the washed cream down to pH about 4.3, the longer the churning time.

Lipolysis

Ordinarily, we consider that the increase in acidity of milk and cream is due to the production of acids by the growth of bacteria, but under certain conditions the acidity of the milk and cream increases definitely in the absence of any appreciable number of bacteria. For a while it was thought that this increase was due to the action of bacteria which had not been detected in the milk, but it is now generally accepted that this increase in acidity is a result of hydrolysis of the milk fat by enzymes with the liberation of the free fatty acids, and it is these free fatty acids which cause the increase in acidity. In raw cream held below 40° F. this increase in acidity may amount to 0.05 per cent expressed as lactic acid, in 24 hours. In addition to this difference, detected chemically by the increase in acidity, the presence of the free fatty acids gives to milk and cream an undesirable odor and taste, often described as bitter, butyric acid or rancid.

Much work has been done on the conditions affecting the lipolysis of milk fat. It has been found that if cream is to be separated from milk, particularly to produce viscous cream in winter, it is advisable to warm the milk to about 120° F., then cool it to the separation temperature of about 70–80° F. When this is done, the cream shows relatively little lipolytic activity as compared with cream separated from cold milk warmed to the separation temperature. Tests show that lipase is present in both creams but in one it is inactive. This result indicates that the previous temperature treatment of the milk has a profound effect on lipolytic action in the cream separated from it. It has been shown very clearly that when cold milk is warmed to 30° C. and then cooled to some low temperature, the lipolytic action is very much greater when compared with milk which has not been subjected to this cooling, warming and cooling or has been cooled and warmed to any higher or lower temperature. The term "temperature activation" has been applied to this process.

It has been shown that the normal fat globules of milk or cream show greater lipolytic activity the lower the temperature of holding. This is particularly true in regard to cold milk heated to 30° C. and recooled to a series

of temperatures. Thus, fat globules with natural surfaces show a negative temperature coefficient of lipase action. In other words, the lower the temperature the greater the increase in activity. This is contrary to the expected effect of temperature on enzyme action, and is the only case of a negative temperature coefficient of enzyme action of which I am aware. This negative temperature coefficient is confined to fat globules having the natural surfaces. If milk fat is reemulsified in skimmilk to produce milks or creams containing fat globules of approximately normal size, the temperature coefficient of lipase action is positive—that is, the higher the temperature the greater the lipolytic action. Furthermore, such resurfaced fat globules show no additional activation effect upon warming and cooling. The mere resurfacing of the fat globules serves as an activation mechanism. The fat does not need to be removed from the milk in order to resurface and activate the lipase, but it can be resurfaced and activated by homogenizing the milk or cream.

The concentration of substrate, that is, the percentage of fat in the milk or cream has been found to influence the character of lipase action. When raw products containing increasing amounts of fat were temperature activated, it was discovered that with an increase in fat up to about 6 to 8 per cent, the water phase increased in titratable acidity up to about 0.05 per cent expressed as lactic acid, and that no further increase in acidity of the water phase occurred at higher fat contents. Up to about this same fat content, the acidity of the fat per unit of fat increased, and from this point on decreased, although the titratable acidity of the total fat present increased with the increase in the amount of fat in the cream. This indicates that the lipase action on glycerides containing the short chain fatty acids which are soluble in water is stopped by the accumulation of the fatty acids in the water phase, but that the lipase continues to hydrolyze the fats of the longer chain acids—acids which do not dissolve in the water but remain in solution in the fat . . . until these also accumulate to an amount sufficient to stop the action. This points to studies on the reversibility of lipase action and the selective hydrolysis of the various glycerides of milk fat by the same enzyme system under conditions varying principally in respect to the concentration of substrate and ratio of water to fat phase.

The specific surface properties of the fat globules exert a profound effect upon the rate of lipolytic action. This was demonstrated by experiments with re-mixed milks. Skimmilks from a number of individual Jersey and Holstein cows were used. The lipase resides in the skimmilk or water phase. Two series of skimmilks, one series obtained from Jersey cows, the other from Holsteins, were used. The same cream was added to both series. We thus had two sets of samples, each set containing the same amount of the same fat and of the same kind of fat globules. We would expect the lipolytic action in the two sets of samples to be directly parallel and comparable.

This was not the case, indicating rather specific properties of the surfaces of the fat globules.

The acids liberated by lipolysis of milk fat exert an effect upon salt equilibrium, surface tension, foaming, and churning. The fatty acids liberated lower the surface tension and tend to create a stable, soap-like foam. Due to the formation of soaps in the water phase, this type of foam structure interferes seriously with churning. From the practical standpoint, the high lipolytic activity of the milk from cows in advanced lactation pronouncedly retards churning and often milk or cream in winter is pasteurized as soon as possible in order to inactivate the lipase and overcome this difficulty.

Gravity creaming

The mechanism of gravity creaming has long intrigued investigators. An early explanation was that when the milk was cooled the density of the water phase increased, while the increase in density of fat showed a lag, and it was thought that this increase in the difference in density caused gravity creaming. An idea along somewhat similar lines was that when milk was cooled the heat liberated by the solidifying fat globules caused the rising of the cream. Another explanation was a sort of a swarm theory, the idea being that the large fat globules overtook others and formed a swarm, thus creating a greater unit size, resulting in the rapid rising. It has of course been observed that Jersey milk gives deeper cream layers than Holstein milk, and that fat globules in Jersey milk are larger than the fat globules in Holstein milk. These two variables were connected to form the basis of a theory of creaming and it has been stated that one gets more cream on Jersey milk because the fat globules are larger. It is true that the fat globules are larger but you get more fat from Jersey milk because Jersey milk contains more fat and you get deeper cream lines because an agglutinating substance is present in the milk in approximately the same proportion as the fat, as experiments presented by Palmer and Dahlberg may be interpreted as showing. The difference in size of the fat globules does not explain why Holstein milk or Jersey milk for that matter creams in a few hours.

In recent years application of Stokes' law has been made to the problem of gravity creaming. Stokes' law applies to the rate of movement of small spheres through a viscous medium when moving at constant velocity, due to a gravitational force. Calculations indicate that it would take about 300 to 500 hours at 5° C. (41° F.) for an individual fat globule to move from the bottom to the top of a quart milk bottle. This indicates that gravity creaming does not result from the movement of individual fat globules. We know now that gravity creaming occurs as a result of the clumping of the fat globules into agglomerates comprising hundreds or even thousands of fat globules. These clumps rise according to Stokes' law, and the size of the agglomerates are such that creaming can occur in from one to two hours—that is, the normal gravity creaming time.

It has been found that raw milk contains a small amount of a protein material which will "agglutinate" the fat globules. The term agglutination was applied to the clumping of fat globules some years ago by the investigators at the Hoorn Experiment Station in Holland. The natural agglutinin is adsorbed on solid or solidifying fat globules and causes the globules to clump. It is liberated to the plasma and the clumps fall apart when the fat globules melt, to be readsorbed and cause reclumping upon recooling. The agglutinin is heat labile and solid fat globules do not adsorb the agglutinin after it has been heat altered. The fat globules in heated milk do not clump. The behavior of the agglutinin accounts for most of the known factors of gravity creaming. The properties of the agglutinin and the fat point to a rather interesting way of enhancing gravity cream volumes. According to this idea, agglutinin is present on the fat globules if the fat globules are separated from the milk while the fat is in the solid state, and thus would be absent from the skimmilk. If the fat globules are separated while the fat is in the liquid state, then the agglutinin would not be present on the fat globules but would remain in the skimmilk. Thus, by combining low-temperature-separated cream with high-temperature-separated skimmilk, good gravity creaming milk is obtained, while by combining low-temperature-separated skimmilk with high-temperature-separated cream, poor gravity creaming milk results. Another interesting test of this idea is obtained by separating cream to about 25–30 per cent fat content at a low temperature, and then reseparating the cream to a higher fat content at a temperature at which the fat globules are liquid. This gives a cream plasma which is very much enriched in agglutinin, and recombined milk made with this cream plasma gives very deep cream layers, sometimes yielding 80 per cent of cream on 4 per cent fat content milk. Agglutinin added to homogenized or heated milk which otherwise does not cream causes the fat to cluster and produces good gravity creaming.

Cream viscosity

Under proper conditions the presence of the natural agglutinin in cream yields cold cream of high viscosity. The agglutinin will be present in the cream if the cold milk is separated at a low temperature. It was observed a number of years ago by Dahlberg that if milk was pasteurized, cooled, and held cold for a few hours and then separated it would yield a cream of as high viscosity as that obtained from raw milk. The attempt to make the agglutinin go with the cream has resulted in lower and lower temperatures of separation of cream for market purposes.

In the last few years a procedure has been developed whereby cold cream is warmed relatively slowly to a temperature in the neighborhood of 30° C. and then is recooled relatively slowly. Such a procedure tends to increase the viscosity of the cream. A lead toward the explanation of this behavior

is to be found in the effect of such a procedure in altering the physical state of the fat. In the fat as it is originally solidified a great variety of fats crystallizes out. The fat is then warmed until nearly all of the kinds of fats dissolve, but not quite all of them. Then the fat is recooled. On this second cooling, the fat globules are cooled in the presence of seeding nuclei of the most insoluble fat fraction and consequently this fraction crystallizes out more rapidly and completely the second time that it did the first time when it was not seeded. This alters the relative proportions and the rate of crystallization of the fat fractions and yields a different solid phase on this second recooling. For some reason or other this different physical state of the fat on the second cooling has an influence upon the surface of the fat globules, perhaps through a different orientation of molecules and consequently upon the materials adsorbed, which apparently results in this increase in viscosity.

The conditioning of the fat by cooling, warming and cooling activates the lipase in raw milk, produces viscous cream as just described and is used to condition milk chocolate for candy coating. Evidence has been obtained by Rishoi that the specific heat of this recooled fat is different from that of the fat cooled the first time.

Composition of natural material on the milk fat globule surface

The identification of the materials present on the surface of natural milk fat globules has attracted investigators for years. In the various reports we find that nearly everything present in milk has been reported by some investigator to be adsorbed on the surface of fat globules. Among the early investigators was Völtz, who found lactose, ash, casein, and albumen were all adsorbed on the surface of the fat globules. His results were obtained because of faulty technique of separating the fat globules. He separated some skimmilk (plasma phase) along with the fat and consequently when he carried out his analysis he found these skimmilk components. Others have made errors of this kind in separating the fat globules. Storch concluded that the material was a protein of mucin type because it had reducing properties. He separated cream, mixed it with water, and reseparated it, repeating this procedure four times. He thus displaced the skimmilk phase with water and concluded that the protein remaining was on the surface of the fat globules. He found 2 grams protein adsorbed on 100 grams fat. Van Dam and Sirks made protein analyses on skimmilk and cream and discovered that the protein content was higher in cream when calculated to the basis of the water phase. The difference between these two analyses was attributed to the protein adsorbed on the surface of the fat. They found that 0.29 to 0.82 average 0.47 gram of protein on 100 grams of fat. Whitaker, using the washing method, concluded that about 0.31 to 0.56 gram, best value 0.35, was present on 100 grams of fat. Hattori found that a protein different from

the others in milk was present on the fat. Palmer and his co-workers washed cream a few times, churned it, and assumed that the surface material and surface material only was liberated in the buttermilk. They concluded that the protein obtained had not been identified previously. They also found phospholipid material and concluded that ether extractable non-phospholipid material comprised 50 per cent of the membrane.

Recent results indicate that the reddish color of raw cream buttermilk is due to a flavoprotein. Using a method which would differentiate between free flavin in milk and the flavoprotein, it was found that there was present on the fat globules about 0.07 gram of flavoprotein per 100 grams of fat. This flavoprotein appears to be the Schardinger enzyme or xanthine oxidase. Calculations indicate that 66,000 molecules of this enzyme material are present on the surface of each fat globule. The flavoprotein may adhere quite persistently to the surface of the fat globule, and at least half of it cannot be removed by washing.

Rimpila and Palmer show that after washing six times 50 per cent of the phosphatase activity remains with the cream. This shows phosphatase in the membrane.

In addition, it has been shown that at cold temperatures the agglutinin is adsorbed on the surface of the fat globules, but the evidence is that the agglutinin was removed in the washings in the procedures used for isolating the materials on the surface of the fat globule, and consequently the agglutinin was not present in the surface material analyzed by other workers.

Davies has shown that a copper protein compound is adsorbed on the surface of the fat globules, and that copper added to milk is present in a greater proportion on the surface of the fat globules than would be accounted for by equal distribution throughout the milk.

Sirks, as well as Sommer, has studied the electrical charge on the fat globule and the fat. Sirks could find no relation between charge on the fat globule and creaming, whereas Sommer concluded that alterations in electrical charge explain some of the differences in gravity creaming.

Resurfaced fat globules

Various attempts have been made to redisperse butterfat and recreate fat globules in milk or cream having the same properties as the naturally surfaced fat globules. On the whole, these attempts have been unsuccessful. The product will not churn properly, or it will not withstand washing with water, its reaction to lipase is altered, it will not have the Schardinger enzyme reaction, and almost invariably it will yield clear whey when the attempt is made to filter it. These products ordinarily do not give normal gravity creaming, but some of them will cream normally if agglutinin is added.

In this talk I have tried to present to you a picture of the research that

can be carried out on an object so small and so much taken for granted as the milk fat globule. I hope I have been able to convince you that research on the fat globule is worth while and has led to results which are of scientific interest and of practical value.

PRESIDENT'S ADDRESS

The thirty-fifth annual meeting of the American Dairy Science Association takes me back in memory to the corn-growing days of 1906, when I came to Purdue University from Ohio State University to join my friend and classmate, Fred Rasmussen.

We Iowa lads then journeyed to the University of Illinois to attend a meeting of dairy instructors and investigators which was called to convene during the first session of the Graduate School in Agriculture. This school met at different colleges of agriculture on alternate summers for several years. It was at the first meeting of this school that Professor W. J. Fraser, Chief of the Dairy Department at the University of Illinois, assembled a group of instructors and research workers on July 17, 1906.

After several periods of presentation of papers and discussions, an organization was launched. Fortunately, that little group, the general appearance of which is recorded in the first picture, had in it several individuals of splendid leadership and who soon became world characters. My friend, Fred, and I were junior members of this new enterprise and I can assure you that we were impressed by the information that we obtained. Later we realized that still more important than the knowledge that we received was the friendship of the older men.

I hope that it is realized that the task of preparing a short historical sketch is not an easy one. Perhaps, however, I can continue in giving a review that will be of value to our younger members.

A brief meeting of our Association was held at the National Dairy Show in Chicago, Illinois, on October 11, 1907. The next session was in the summer of 1908 at Cornell University, where the Graduate School in Agriculture met for the second time.

The first president, the former Professor R. A. Pearson, offered a comment on a change in name in the beginning paragraph of the president's address. He stated: "The name of our organization is not descriptive of its character. We call it 'The National Association of Dairy Instructors and Investigators' yet some of our members represent the great dairy interests of Canada. It is then, strictly speaking, not a national organization. . . . I would like to suggest as a new name, 'Official Dairy Instructors Association.'"

When meeting under the new name on October 24, 1910, in Chicago, Illinois, our second president, the former Doctor C. H. Eckles, voiced an expression for cooperation, which I wish to quote. Before I read his state-

FOUNDERS OF THE AMERICAN DAIRY SCIENCE ASSOCIATION, UNIVERSITY OF ILLINOIS, 1906.

(1) C. C. Hayden, Illinois, (2) J. W. Decker, Ohio, (3) C. F. Doane, U.S.D.A., (4) W. J. Fraser, Illinois, (5) H. A. Hopper, Illinois, (6) J. M. Truman, Illinois, (7) C. H. Eckles, Missouri, (8) E. H. Webster, U.S.D.A., (9) A. C. True, U.S.D.A., (10) H. H. Dean, Ontario, (11) C. B. Lane, U.S.D.A., (12) Fred Rasmussen, Indiana, (13) C. E. Lee, Illinois, (14) O. F. Hunziker, Indiana, (15) E. S. Guthrie, Ohio, (16) H. E. Van Norman, Indiana, (17) Charles Thom, U.S.D.A., (18) Eugene Davenport, Illinois, (19) B. D. White, U.S.D.A.

ment, may I say that sometimes I think it is almost sacrilegious for a presiding officer or any one else, to offer comments on an excellent statement or address. That is my sentiment as I read this paragraph from Doctor Eckles.

"Dairy husbandry is the application of several sciences to certain practical lines and for this reason a man directing such work should have a rather broad training without being, necessarily, a specialist in any one. When a chemist alone undertakes to carry on an investigation with animals he is apt to overlook some essential points in treatment of the animals used and he is not in a position to know the problems that need solution from a practical standpoint. On the other hand one filling a responsible position along dairy lines does not have as a rule the intimate knowledge of chemistry and especially of physiological chemistry necessary to properly carry on research to good advantage. The man in this position, however, has an opportunity to know the problems that the practical man wants solved and he should combine with this the technical knowledge of the management of the animals or the manufacture of the dairy products as the case may be. The plan that must be followed in the future, if we gain much headway, is to work in groups. One of the group must have a broad general knowledge and be familiar with the practical side of the problem. Associated with him must be competent chemists, physiologists and bacteriologists, according to the problem at hand."

On October 29, 1912, in Chicago, Doctor O. F. Hunziker, our third president, when speaking of the accomplishments of our Association, made this statement:

"We have grown not only in members but also in the scope of our activities and usefulness and our results have gained recognition in state and nation. We have accomplished the standardization of Babcock testing glassware, so that today, it is possible for anyone to secure standard glassware that is correct, accurate and uniform so that the results of its use are comparable. We have been instrumental in the unification and perfection of a national score card for scoring dairies, in the purification of national judging contests and in the modification of the national standards for milk products.

"We have discussed and analyzed, for the benefit and information of all, the principles and methods of instruction in dairying, our relation to the breed associations, experimental work in milk production and dairy manufactures, proper standards for dairy products, standard methods of testing milk and dairy products, plans and methods for judging dairy cattle and the securing and awarding scholarships for students judging contests and of graduate scholarships, and means and methods for the efficient administration of dairy extension work. All these activities have been effective means to bring us closer together in our work, to unify our efforts, to make more effective our results, and to stimulate our enthusiasm."

It may be of interest to our members to know that the influence of our Association is still being felt in the making of laws relative to dairying. The legislative bodies of New York State at their last session carefully studied the well-prepared report of one of our recent committees on the

standardization of milk. A law on this subject has not yet been made in New York. When it is written, however, this report of our Association will have its influence. This is only one illustration of the important position that is held by the American Dairy Science Association in the dairy industry. There are many other examples of the value of our organization to dairying that should be mentioned.

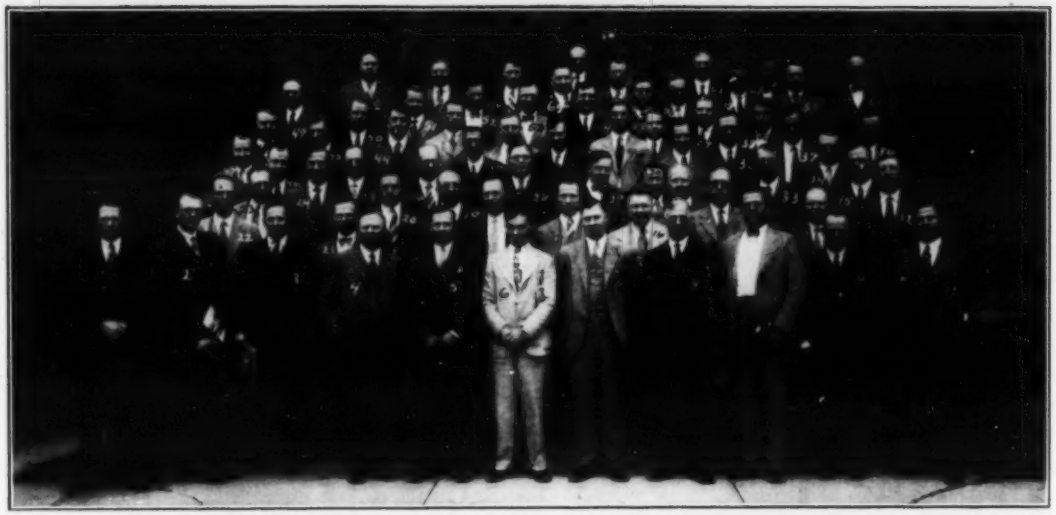
The time came again for a change in the name of our organization. There is a letter under the date of March 19, 1917, that is pasted in the secretary's records, which contains this important final paragraph: "As the result of the action of the Society at its last meeting and as the result of the vote which has just been taken, the 'Official Dairy Instructors' Association' has become the 'American Dairy Science Association.'" This communication was signed by W. A. Stocking, Jr., President, M. Mortensen, Secretary, and H. A. Harding, whom I suppose was the chairman of the committee on the choice of a new name.

The most important development through the years was the establishment of the JOURNAL OF DAIRY SCIENCE, the first copy of which came to our desks in May, 1917. I would like to spend several minutes on this significant feature of the life of our Association. I think that it is apparent, however, to all of our members.

Now may I call attention to our meetings and programs. There were a few summer gatherings during the first years of our history. Most of the early meetings, however, were one-day programs that were held some time during the National Dairy Show. It was convenient, of course, for our members to attend the Show and our convention in one trip. Nevertheless, from the standpoint of a good convention, it was not a satisfactory arrangement. The day's work was made up largely of a few papers and discussions and committee reports. Some years the committee reports crowded the papers clear off the slate.

Something had to be done to change this condition of our programs, so we again tried the summer plan in a meeting at Michigan State College in 1927. If I recall correctly, it was a two-day session. This meeting met with the approval of all our members who attended, so we have continued it. In terms of today, our attendance was not large. From the viewpoint of quality you may observe the second picture. One new feature that came to us at our summer conclaves was that of having our families with us. That new departure which adds to the social life of our meetings makes our conventions almost old home-comings.

About this time, in the development of our Association, research, and problems in teaching were rapidly increasing, with the result that many papers were listed on the programs. In fact, valuable discussion has almost been smothered out. Our program committee, however, is endeavoring to return it to its proper place.



AMERICAN DAIRY SCIENCE ASSOCIATION, MICHIGAN STATE COLLEGE, 1927.

(1) W. H. E. Reid, (2) Otto Schaeffer, (3) W. H. Martin, (4) J. H. Frandsen, (5) George White, (6) J. B. Fitch, (7) J. M. Sherman, (8) C. H. Eckles, (9) H. A. Ruehe, (10) W. M. Regan, (11) O. E. Reed, (12) H. P. Davis, (13) E. L. Anthony, (14) R. B. Stoltz, (15) George Gerbach, (16) ....., (17) ....., (18) A. J. Cramer, (19) R. S. Breed, (20) .....,(21) J. C. Hening, (22) A. C. Baltaser, (23) ....., (24) R. C. Fisher, (25) S. I. Bechdel, (26) M. J. Prucha, (27) E. B. Meigs, (28) ....., (29) ....., (30) L. H. Addington, (31) H. G. Lindquist, (32) P. S. Lucas, (33) R. J. Harris, (34) A. C. Dahlberg, (35) G. E. Holm, (36) E. J. Perry, (37) W. A. Wentworth, (38) W. M. Neal, (39) ....., (40) A. C. Ragsdale, (41) P. F. Sharp, (42) P. A. Downs, (43) ....., (44) ....., (45) ....., (46) A. M. Harmon, (47) L. A. Fairchild, (48) R. C. Potts, (49) ....., (50) H. W. Cave, (51) W. E. Krauss, (52) O. C. Cuningham, (53) W. V. Price, (54) E. S. Guthrie, (55) C. E. Wylie, (56) A. R. Merrill, (57) L. M. Thurston, (58) N. S. Golding, (59) H. O. Henderson, (60) G. M. Trout, (61) ....., (62) F. W. Bouska, (63) D. S. Kochheiser, (64) A. E. Perkins, (65) J. C. Marquardt, (66) ....., (67) ....., (68) J. A. Nelson.

A paragraph should be given to our officers. In the early days we elected the president, vice-president, secretary-treasurer, and editor at the convention instead of using the method of the whole-membership ballot through the mail, as is our practice now. At that time there was no board of directors. In order to obtain better management of our growing organization, the Association decided, after a few years of evolution in administration, to elect a revolving board of six directors. Two new members of this board are elected each year, and two members retire each year after three years of service. The elective administrative members include also the president, the recently retired president, and the vice-president. After a period of service of one year the vice-president automatically becomes our president. The secretary-treasurer is appointed by the entire board of administration and he has an important place in the transaction of the business of the Association. The editor also is appointed now by the whole board of administration on the nomination of the journal Management committee.

Greater continuity of management has been acquired by this new type of administration. The dispatch of business operation has been greatly increased. Particularly satisfactory has been the procedure of passing all committee reports through the hands of our secretary.

The main channels for individual service are through committees. Our Association has been blessed with many members who have been willing to give time and thought to the activity of our organization. They have found many opportunities, for the charter members left the first convention with seven standing committees. We assemble at the thirty-fifth annual convention with 59 committees and 218 committeemen. Fifty of our members are serving on two committees. Seventeen of them have been appointed on three committees. Six of our representatives are laboring on four committees. Three industrious scientists are floundering along on five committees. P. A. Downs is in a class by himself for he is on six committees. Our Association is grateful to these loyal men.

One of the most successful efforts of our journal has been that of the abstracts of literature. The abstractors number 104. They review articles in a concise fashion that are selected from 68 journals and 9 special publications. Among these generous persons there are 65 who are serving on one or more of our committees. It is needless to say that we owe them all a debt of gratitude.

I am sure that our board of directors will join me in paying special recognition to the zeal and wisdom of the officers of the Dairy Production, Dairy Manufactures, and Extension Sections. I, also, know that our board will voice with me a parental solicitation of "good wishes" to the Southern, Eastern, and Western Divisions of our Association.

I wish that I, with 34 years of interest and activity in this Association, could successfully transmit a special message to our younger members. Per-

haps, at this stage of my address, I can gracefully refer to the call of our second president for group study.

During the last four years it has been my privilege to be one of a three-man team on a certain research problem. We have met with greater success than if we, each, had worked alone. This has meant to me a special effort throughout the period to accommodate my plans to those of the majority in order to maintain good teamwork. I, of course, have realized that the other men were doing likewise. Generally, I think that a member of a team should expect to meet the convenience of the others, at least 75 per cent of the time. It is very necessary that he should go more than half way in time, ideas, and the like that pertain to the work of the team. For illustration, a week ago yesterday I found shortly after eight o'clock in the morning that the team wanted to run two sets of milk in our study of deaeration. As it happened, that was commencement day and I had hoped to remain at my desk for a while and then to go and pay honor to the graduating class. Instead, I immediately jumped into my white suit. I ate my lunch as I worked, and I left the laboratory at 6:15. I did not feel badly because of the change in my plans. Naturally changes come. I am accustomed to them. The recompense is greater accomplishment.

One of the fundamental factors in group activity is the disposition of the teammates. I find it ever present and radiating. It bothers me. Not long ago I heard a question that was being asked in my native state. "Why does Iowa have more Scotchmen than Missouri, and why does Missouri have more mules than Iowa?" The answer is: "Missouri had first choice." If in training my mind and in gaining intelligence, I only had made a wee bit of an effort to enjoy a good joke, to tell satisfactorily a humorous story, or to catch a spark of humor in a stern situation; if only in some way I had been led not to see first the dark side of a new proposition, but rather to recognize immediately the brighter aspects; perhaps then my contributions to the group effort would be appreciated. It might be that I would be less aggravating to my teammates. Possibly then I could help iron out a few of the little difficulties that occasionally occur as the days follow each other.

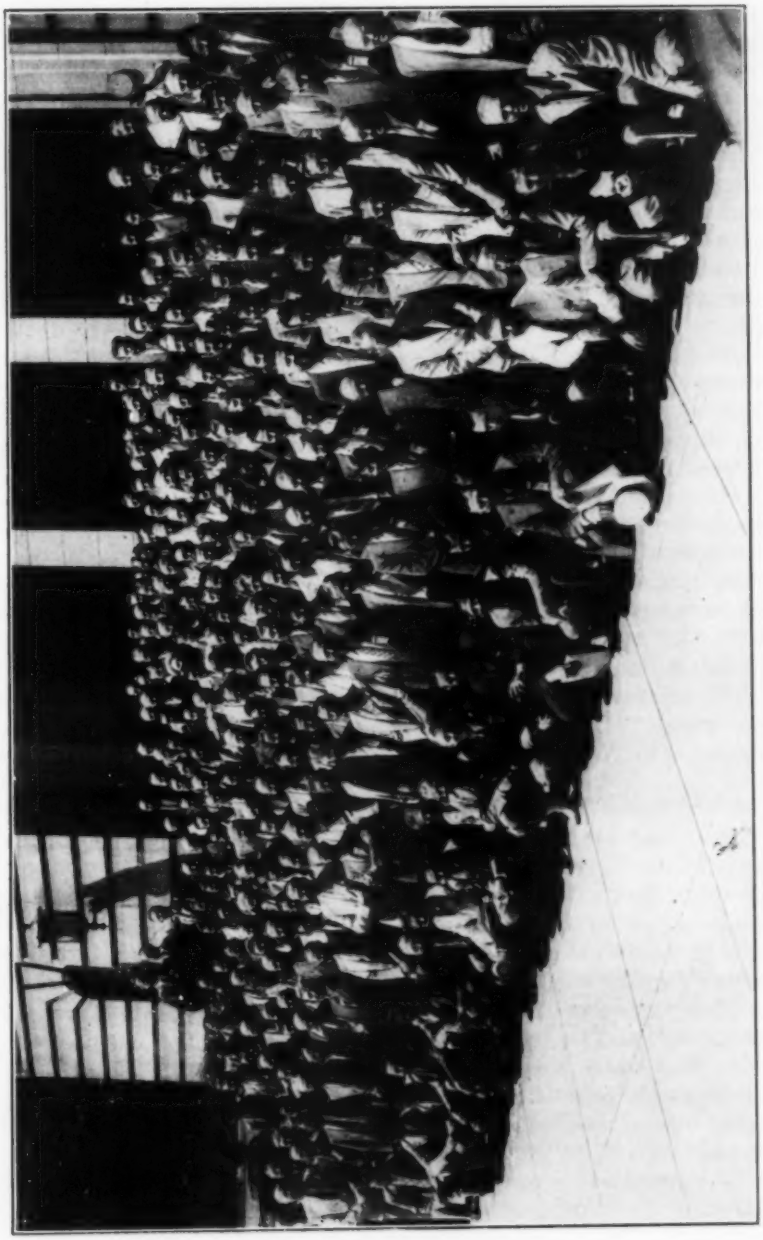
The endeavor of our Association for united effort in dairy science has extended in personal interest from the 17 charter members of the first picture to over 1500 members, many of whom may be found in the third picture which will be taken during the convention here at Purdue University.

There were 265 members present. The meeting adjourned at 11:30.

GENERAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

West LaFayette, Indiana, June 27, 1940

President Guthrie called the meeting to order at 4:00 P.M. in the Purdue Memorial Union Building, there being 204 present, and gave the following address:



THE AMERICAN DAIRY SCIENCE ASSOCIATION, PURDUE UNIVERSITY, 1940.

We are assembled now to pay homage to the memory of Dr. S. M. Babcock, in this program commemorating the "50th Anniversary of the Babcock Test." Naturally when we realize the value of certain contributions of science to the dairy industry we think of the efforts of many individuals.

A few years ago I heard Dr. J. L. Hills, Dean of the College of Agriculture of Vermont, say that as a young chemist he was well on the way of developing a test for milkfat in dairy products when Babcock's method appeared. The demand of the times had stimulated these two men to work on that problem simultaneously. These studies occurred in the lifetime of a man who is still active, so we must know that we are employed in a rather youthful field.

Dean Hills related how he went to a dairy plant one morning to obtain samples of milk where there were forty-one patrons. Forty of these milks had been skimmed. He talked to the people about the practice and found that one reason for the milk being particularly thin that day was because there was to be a church strawberry social that night.

I am planning, during our convention next year, to visit some of the cemeteries in New England and commune with some of my ancestors on some of their religious standards.

Dr. Babcock was our guest of honor at the banquet when our convention was held at the University of Wisconsin in 1928. We all returned to our homes with pleasant memories—memories of Babcock the scientist, and Babcock the man.

It is now my privilege to present to you Dr. H. C. Jackson, chief of the Department of Dairy Industry, who will have immediate charge of the program.

Dr. Jackson then responded:

Fifty years ago this June, Dr. S. M. Babcock gave to the dairy world the test which bears his name. To many of us who had the honor and pleasure of associating with Dr. Babcock it seemed fitting on this 50th anniversary to devote a portion of the program of the association in commemoration. In these troubled times when whole nations appear to be questioning the very fundamentals underlying our civilization it is refreshing to review the life of a great scientist who pioneered in the field of Dairy Science and who used his gifts for the improvement of not only the lot of dairymen but humanity as well. It is hoped that such a review of his life and activities will serve as an inspiration to the younger members of the association who are just entering their life's work as dairy scientists and that some who are older may have their courage and faith renewed.

Dr. Babcock was a great scientist, a great teacher, and a great man. We are fortunate indeed in having as a speaker on this program a man, a mem-

ber of the association, who was intimately associated with Dr. Babcock in his work at Wisconsin. I know of no one who is better able to pay a tribute to Dr. Babcock than Professor E. B. Hart, Chairman of the Department of Agricultural Chemistry of the University of Wisconsin, who will address us on "Dr. Babcock, the Scientist."

Professor Hart then said:

If Dr. Babcock were with us today he would wish that we have the merriest time possible. For as Glenn Frank characterized him, "He was the Laughing Saint of Science."

Dr. Babcock spent more than forty years in our midst and it was a great experience to know him well. I first met him in 1906, the year in which I was asked to become associated with him in discharging the duties of the Department of Agricultural Chemistry. I shall never forget his trudging the streets with me looking for a house in which to live and taking as much personal interest in me as a father. I learned to know that that was his nature—a helpful spirit always giving sound counsel and always willing to lay aside his own work to discuss your problem. With my coming to the department he was freer to work on problems of no immediate practical moment, and we found him active in his laboratory on the fundamental questions in plant and animal physiology, namely, metabolic water. This piece of work is now considered a classic by plant physiologists, and to animal physiologists it explains how a clothes moth can live on dry clothes and produce larvae containing 75 per cent of water. Dr. Babcock's grip on science was thorough, for he had had superb training at Cornell University and the University of Göttingen, Germany, after having taken his A.B. degree at Tufts College. He brought to his problems a thorough understanding of mathematics, physics, and chemistry.

He always delighted in telling his friends of his experiences in Göttingen University where he was a student of Huebner, the successor to the great chemist Wöhler. Wöhler was then a very old man, revered by the students who knew him, and almost daily walked through the laboratory where Dr. Babcock was at work. On one occasion Dr. Babcock asked a fellow German student, "Who is that old duffer shuffling through here?" To be replied to in scorn, "Don't you know that that is the famous Wöhler?" In Wöhler, Dr. Babcock found a most lovable man, and he never tired of telling how Wöhler showed him a sample of the first urea that was synthesized and a bit of iodine that was sent by Courtois in Paris to Wöhler. It was a sample of the first iodine that had been isolated and it was in a small sealed glass tube. The sample was so minute that it appeared as a small speck in the tube and only by warming the latter and causing the violet vapors to form could one be sure that the tube contained iodine.

Dr. Babcock also visited Bunsen at Heidelberg and was greatly impressed

by the simplicity and originality of that great chemist. I have always suspected that much of the simplicity of his own experimental work grew out of the impressions he received from those early chemists.

In the popular mind Dr. Babcock will be remembered longest for his invention of the milk fat test which bears his name. He has told me many times that his real contribution to the development of this test lay in his introducing the centrifuge as a part of the test, thereby shortening the time of operation. Here again his fundamental knowledge of physics stood him in good stead. Probably no contribution to agriculture by a scientific man has helped more to gain the respect and confidence of farmers in agricultural experiment stations than the Babcock test. But this inventive genius also developed a viscosimeter, the construction of which in principle is the basis of the modern viscosimeter. He chuckled and laughed as he told of this invention, for after it had been perfected to his satisfaction he found that the same principle and the same type of instrument had appeared in the German literature some twenty years before his own invention.

Dr. Babcock was a thoroughly religious man—if we may define a religious man as one who is humble before the Unknown, rather than a blind follower of theological ritual. In his early life he lost a job because he would not take part in the religious exercises prescribed for students at a certain eastern institution. He had been recommended to the position of chemist at this institution and while looking over the position was entertained at the president's house and was definitely offered the job. On the morning that he was to depart from the institution, and was having breakfast with the president, the president said, "Now, Mr. Babcock, there is one thing that I haven't mentioned to you and that is that all members of our faculty take part in the daily chapel exercises held for our students, and of course you will be expected to take your part." Dr. Babcock, with a merry twinkle in his eye, said, "Mr. President, if I come to this institution I come as a chemist and not to take part in these religious exercises," and with that understanding he went back to Cornell University never expecting again to hear from the president of the eastern institution. In a few days he did hear that he had been appointed to the position, but he said that he was very glad that he could inform the president that he had already accepted a position at the Geneva Experiment Station.

Dr. Babcock was a thoroughly practical man although sometimes his advice bordered on the ridiculous. I well recall the incident of one of our faculty leaving for the Pacific Coast to lay out a new city below San Diego. Doctor was sought for advice on what he thought might make a model city. He believed that it would be impossible in that climate to have sufficient milk for a growing population as produced under ordinary circumstances and so implored his friend to try the novel experiment of domesticating South Pacific whales to give up their milk to be pumped through a pipeline from

the ocean slip. So far as I know the experiment was never carried out, but it illustrates the originality of the Doctor and his willingness to try what he often called "the fool experiment." He symbolized what A. V. Hill once said, "It is dangerous to speculate too far, but it is foolish not to speculate at all."

In Dr. Babcock's life there was no lull in activity and interest in scientific problems. He never seemed to grow old. At 87 he was still active on the problem of the constitution of matter, a problem which had always interested him since his student days at Cornell. It has always seemed to me that the many things he talked of in reference to the constitution of matter 30 and 40 years ago when I first knew him have come to be a part of modern physics and modern chemistry. True, he was crude in his experimentation, but the ideas were there waiting for someone to prove or disprove. Physicists often quote the famous Morley experiment refined and carried out to the fifth decimal place as giving the atomic weight of oxygen. In some early experiments in weighing gases that Dr. Babcock himself carried out, he saw how a considerable error could creep in through the outside pressure upon the weighing flask, thereby distorting its shape. He wrote Morley asking if he had given consideration to this possible error in his own work, but Morley never replied, being conscious, I think, that he himself had actually committed a serious error. Dr. Babcock only chuckled and went on his way.

When he died he left a manuscript which we still have in the vault and which was the fruit of his labor and thought on the constitution of matter. I have read it through several times, and to me it was a new physics, but after submitting it to mathematicians and physicists upon our own campus with the thought of its publication, they were unanimous in believing that it was too qualitative in its character to warrant its publication and that possibly it might detract from Dr. Babcock's standing as a scientist.

After hearing their verdict I went to each one personally, not knowing enough about the subject myself, and said, "Isn't it possible that there is some hidden gem of thought in this manuscript that has escaped your critical attention and which might be lost if the manuscript were not published?" They all agreed that they did not think that to be the case. I still wonder whether they are right and whether our leading scientists may not often make the error of being grooved in certain channels of thought until they are roused from them by some wholly new and original idea.

His was the inquiring mind under all circumstances. When the tomatoes failed to grow in his garden the cause must be known. Instead of planting in a row, the next crop was planted in a circle and only those plants in the old row died. That row was underlain by an ant run and the cause of failure solved.

Dr. Babcock received many honors. But I don't know of one from which

he had more fun than that which grew out of the Capper award. After it became known to the public that he was to receive $5,000 plus a medal, he was hounded by many people, including reporters, as to what he expected to do with the money. In his very characteristic way he told them he was going to buy peanuts with it, and of course this story got into the press. Out of it from all over the country came many appeals for financial help. It was evident that many believed that his mind had failed and that he could not possibly be responsible for the further handling of his own affairs. There wasn't a day that he didn't come to the laboratory with a letter or two to tell of the most recent request for help. One farmer in the north had suffered a great fire, his barns were all down, but he had money enough to rebuild everything but the hen coop—and if he could only have $500 he could rebuild the plant and again be on his way. A daughter was burdened with the care of an invalid mother; they were poor and needed help. The mother needed the out-door air, and if they could only have money enough for an automobile, health would be immediately restored. The Doctor would again laugh—and when he laughed, he laughed all over.

The present century has seen a great development in our knowledge of animal nutrition. Dr. Babcock's contribution to that development is not generally known. He lighted the torch for others to carry on. When chemist at the Geneva Experiment Station in 1882–1888, Dr. Sturtevant, the director of the station, wanted him to make some of the conventional analyses then and still in vogue on foodstuffs. The work involved not only the analysis of the food but also the analysis of some of the metabolic by-products. After he made the analyses and reduced the results to an ash free basis, the composition of the food was much like that of the metabolic by-product. From that time on he lost faith in the possibility of the prevailing methods of food analysis to give valuable information about the nutritive value of a foodstuff. He also had little faith in the then prevailing and developing notion that the energy of a foodstuff would measure its nutritive value. The mind of the skeptic was again at work. He delighted in telling the American nutrition leaders of forty years ago—Atwater, Armsby, or Jordan, all champions of the idea that the energy of a food measured its nutritive value—that if energy were the measure, then hot water or coal should be the most excellent of foods. When he came to Wisconsin he put his ideas to work in testing with cows, rations alike according to conventional methods of food analysis and energy content but selected from different sources, with marked differences in the resultant milk production and behavior of the animals. His notes were incomplete, but from no fault of his own, and so he never published the data. That work was really the forerunner of the larger development at Wisconsin of the newer knowledge of nutrition, and the first experiment with large animals, so far as I know, using the biological method for testing the nutritive value of

foodstuffs. It was a new idea and Dr. Babcock was father of the idea. Others have carried it on. Had the idea been lacking, we might still be in the hands of the energy exponents.

Dr. Babcock was a most lovable character and exemplified modesty and simplicity in every thing he did. He had a profound influence upon the character of the scientific work done in our college, and possibly the whole University. New ideas, free discussion, kindly interest, and above all his novel and helpful suggestions were an inspiration to many. He never threw a blanket over his apparatus when visitors came to see him. If interested, he hold them fully what he was doing. When he suggested "the fool experiment" he started a new train of thought and out of it came a new birth. He would rather have an experiment fail than succeed if through its failure it taught him to plan for the next. Truth must always prevail. Babcock was not a victim of the routine. The clock could not be regulated by his daily activities. Often he would come to the laboratory to tell me with much enthusiasm that he now had the solution of his problem—and then six months might elapse without reference to it. We thought he had forgotten about it, but not so. The incubation period was on; the first explanation was wrong; he was on a new tack, and soon he would be bubbling over with new enthusiasm. His researches ran in cycles but never ceased.

He represented the liberal in research, and there can be little fundamental research if executive regulations dominate the time of men. His profound understanding and sympathetic nature made him a great teacher, and like Agassiz he is remembered by many whose questions were not answered but who were started on the way to learn for themselves through their own efforts.

Dr. Babcock published little. His influence was felt more through his interests in and suggestions to others. His counsel was always available and his ideas fresh and original. Fourscore years and more did not abate his interest in the experimental work of science. Babcock would have made any institution great, and it is Wisconsin's fortune to claim him for her fame.

Dr. Jackson then introduced Dr. Bohstedt saying:

In the address, which has just been concluded by Professor Hart and his presentation of Dr. Babcock, the scientist, he has given us a brief glimpse of Dr. Babcock, the man. I well recall my first meeting with Dr. Babcock. In the fall of 1927, I was called to the University of Wisconsin to assume the duties of chairman of the Department of Dairy Industry. Although Dr. Babcock at that time was well along in his eighties, he was one of the first to call on me in my office. I remember his saying, "Jackson, if there is anything that I can do for you, don't hesitate to call on me." You can well imagine the impression that this made upon me to have a great scientist

come and offer his services, and the fine thing about it was that he meant it, and that he was in a position to make such a genuine offer. Dr. Gustav Bohstedt, our next speaker, was intimately acquainted with Dr. Babcock. As Professor Hart has pointed out, Dr. Babcock was accompanied by Professor Bohstedt on picnics, various athletic contests, and other social gatherings, and he is certainly well qualified to give us our next address on Dr. Babcock, the man.

Dr. Bohstedt then replied on "Babcock, the Man."

Near the center of the dining room of the University Club in Madison is a table which, by members who knew him, will always be referred to as the Babcock table. Each noonday during the last years of his life, or ever since the death of Mrs. Babcock, the doctor would enter the Club, put his cap in his coat pocket so that later he would not have to hunt for it in any dimly lighted cloakroom, and join a half dozen colleagues at that table.

A vacant chair here seldom went begging. It was a privilege to sit in with a group of men whose conversation sparkled, in large part because it was stimulated by that octogenarian with the infectious laugh who, by common consent, was wont to sit at the end of that table.

Perhaps it was a story on himself, on the other fellow. No matter. It was bound to be entertaining and somehow memorable. More than likely a question in natural history was being debated. Dr. Babcock to the very last was possessed of an insatiable curiosity. "Each morning he met the Universe with a question." What might cause the peculiar pattern of the grain in birdseye maple? What had caused the disappearance of the passenger pigeon? How was that squirrel in his backyard able to find the exact spot where, on digging, it would find a nut buried the previous fall? Did this squirrel reach it through a peculiarly keen sense of smell, or sight, or memory, or sense of location? Various college faculties usually were represented around that table, and each might claim credit for certain of the phenomena under discussion. Dr. Babcock again and again would bubble over with laughter.

With perhaps only two or three left at the table, and things quieting down, there might be some reminiscence of the doctor from his early life. This might have a most serious side, but almost invariably it would yield its quota of mirth.

Last week at that selfsame table, after war and politics had been discussed, and somehow the name of Babcock had been mentioned, was it any wonder that the group present indulged in nostalgic memories of that grand old man?

How could he help but be revered when he was so approachable and friendly? His international fame sat lightly upon this genial and jolly man. Never need a lowly freshman hesitate to stop him on the street for

a talk. Many a budding journalist would interview him, although the doctor as a prank might turn tables on the interviewer, as he did with a personable young lady who later became prom queen. Dr. Babcock found out all about her family and her history, but gave her nothing in return. Too late, the young lady realized the trick that had been played on her. But the experience appealed to her sense of humor and at various times in subsequent years, to the delight of Dr. Babcock, the young lady would call at his home.

Dr. Babcock exemplified that rare class of people who grow old gracefully. He held old friends and continued to make new ones. A certain boyish quality endeared him to young and old. To the very last he was a lover of sports. The autobiography of John L. Sullivan intrigued him. When his eyesight became too dim to follow football and baseball, he would be found in one of the front rows at basketball games. He would discuss the games in terms of the individual players, showing that it was always the human element that interested him, and which explained in part the hold he had on people. He esteemed his fellow man. Personally, I do not recall that at any time during the several years I had frequent opportunities for visitation, Dr. Babcock ever dwelt on meanness in any individual. Although few were better judges of men than he was, such undesirable traits were passed over briefly. I recall one University administrator telling about difficult sessions with faculty members, when his patience might be sorely tried, only to have his faith in mankind renewed the minute Dr. Babcock, himself the epitome of selflessness and good humor, dropped in for a chat. He would laugh away those difficulties.

But to come back to some of the reminiscences of Dr. Babcock, which stories and anecdotes perhaps bring out the man, or boy, as well as anything else might do. Dr. Babcock grew up on a farm in northern New York. The baseball-minded boys were playing catch one noon when somehow the ball rolled under the porch, the base of which had weeks previously been enclosed with some wooden lattice work. Dr. Babcock laughed when he said that, of course, to recover that ball they would have torn down the whole porch. However, the removal of a side panel sufficed. But what did they find underneath the porch beside that ball? A hen! Ever since the panels had been put in place, after weeks of starvation and therefore quite emaciated, the hen was still alive. There arose the question as to how much water she had had to drink during the several weeks. The young farm boy never forgot this instance. In later years this recollection had much to do with his deliberations and researches on the role of metabolic water in vital phenomena, both plant and animal.

The resourcefulness of young Babcock was demonstrated on an occasion when a barn was to be built and for which a tree-trunk at the top of a hill was to be used for a sill. With his typical spirit of independence, he chal-

lenged his family that with the help of a team of oxen, a log chain, and a two-wheeled running gear, he would by himself bring that log down the hill. In telling of this stunt, the doctor explained that when he got to the log, he took one wheel off the axle and put the tip of this axle underneath the heavier end of the log. He thereupon, by means of a log chain and the use of the oxen, rolled the tree trunk on to the running gear, kept those sturdy old oxen pulling until the free axle was lifted, put back the wheel, and delivered the trunk to the building site.

With his tremendous interest in things about him—in people, in the outdoors, in machines and gadgets—was it any wonder that when a student at Tufts College, where he was obliged to study primarily the classics and literature, he felt himself out of his element? In natural resentment he expressed himself in ways that got him into difficulties. Printed rules governing conduct of students would be found torn off the bulletin boards. But on being questioned regarding this, he would truthfully admit this bit of vandalism. His truthfulness more than once prompted leniency on the part of the authorities. But when along with a fellow student he refused to tell on others for hazing freshmen, he was expelled for three weeks. Considering the natural abilities of Dr. Babcock, it may be surprising to have him admit, as he did, that he was graduated at the foot of the class. Not so surprising, in 1901 Tufts College was pleased to grant him an honorary degree of Doctor of Laws. But Latin, Greek, or the history of the ancients interested him far less than things about him. He wanted to be an engineer and not a literary man. Later at Rensselaer Polytechnic Institute, at Cornell, and at Göttingen University, he had opportunities to satisfy his bent for the physical sciences.

Nevertheless, while living at the outskirts of Ithaca where he owned the old Schuyler farm of twenty acres, and while employed on a part-time basis in the Chemistry Department at Cornell, he joined a literary club. Surely the social life must have been as much of an attraction to him as the nominal purpose of the organization. To hear Dr. Babcock tell about the meetings of the club, the membership did, indeed, mix a great deal of fun with their literary efforts. One of the most exciting episodes that I personally ever heard him tell relates to the attempted "kidnapping" of a recently butchered pig belonging to the family of a member of the club. Circumstantial evidence pointed to Babcock as one of the perpetrators, and one may surmise the suppressed hilarity of the members when at the very next meeting of the club, two phony policemen ceremoniously ushered the unsuspecting Babcock into the circle assembled in mock court. In due course he was fined one-half bushel of peanuts. In far off Göttingen a few years later he heard echoes of this affair, which had been written up in mock seriousness. But it had been taken at face value in Göttingen and no doubt various other places, by people who were astonished that a professor in an American University should stoop so low as to steal a pig!

It is enough to appreciate that this, to some of us perhaps, austere and certainly famous scientist has not always been perfect, but rather has been intensely human. Nevertheless, as one of this man's great admirers has said in his behalf, "It's the little imperfections in our heroes that endear them to us."

In his work at Cornell University he was a special adult student, taking no regular classroom courses. But in his laboratory work he was guided by Professor Caldwell. His rapid progress may be inferred from the fact that at the end of three years, he was asked to take charge of the laboratory and teach a general laboratory course in chemistry. Very likely his experience and associations in this laboratory were as important to him as any in his entire course of training. One may assume that this experience greatly stimulated his independent thinking.

Witness an example of his iconoclastic views regarding gross chemical analyses of feedstuffs as guides to nutritive values. While giving his presidential address before the Association of Official Agricultural Chemists he pointed out to them limitations of such analyses, and as a striking example made the statement that, on the basis of a gross chemical analysis, coal had a relatively high feed value. He elaborated before his listeners that coal surely had both moisture and dry matter. Coal further had a certain amount of nitrogen by the Kjeldahl method, which nitrogen multiplied by 6.25 would be reported as protein. Surely coal had ash or mineral matter in it, in many cases too much of this particular ingredient. Likewise fiber would be found, and ether extract. Then by the usual computation of difference, the remaining part of the dry matter would be reported as nitrogen-free extract.

Such evidences of untrammeled thinking must have stunned a good many of his audience. Small wonder that Babcock was one of the first to observe shortcomings of so-called balanced rations, and should have suggested that animals were in need of nutrient principles other than starch or carbohydrates, fats, proteins and minerals. Surely the present knowledge of vitamins owes a great deal to this man of the "seeing eye and inquiring mind."

Quoting from the Babcock funeral oration of President Glenn Frank:

"He pursued the most painstaking research as if he were playing a game. He brought to his tasks that gaiety of spirit which authentic greatness can afford. His spirit never surrendered that incorrigible playfulness which so often marks men of power. He brought laughter into the laboratory, for there was about him that deceptively careless air which creative spirits have as they go about their business. . . .

"In an age smitten with the passion for publicity, he forgot himself into immortality!

"And in the midst of the sickness of an acquisitive society, his spirit remained unsullied even by legitimate personal considerations!

"Scholar of a great university!
Servant of a great state!
Shy benefactor of mankind everywhere!
Laughing saint of science!
Being dead he yet speaks!"

GENERAL BUSINESS MEETING
AMERICAN DAIRY SCIENCE ASSOCIATION

West LaFayette, Indiana, June 28, 1940

President E. S. Guthrie called the meeting to order at 9:00 A.M. in Purdue Memorial Union Building on the Purdue University campus. Mr. Charles Blackman, Chairman of the Necrology Committee, made the following report of the eight members who passed away during the year:

Professor George E. Morton	July 11, 1939
F. L. Schoenberger	September 2, 1939
J. R. MacLennan	Winter, 1939
Dr. Loyd M. Thurston	February 29, 1940
W. D. Axtell, Jr.	March 28, 1940
R. D. Canan	April 19, 1940
Kenneth J. Matheson	April 24, 1940
Fisher Stilley	May 4, 1940

Upon motion duly seconded the report was accepted to be made a matter of record in the minutes.

Editor Sutton then gave a report which will be found in the minutes of the board of directors.

Manufacturing Section

Secretary Coulter of the Manufacturing Section presented the following minutes; upon motion duly seconded they were accepted with the exception of that part referring to the milk score-card which was deleted from the minutes.

The manufacturing section held its regular meetings at the scheduled hours and places. F. H. Herzer, the Section chairman, presided. The papers presented developed a well balanced program which held the interest of the group as evidenced by the discussions when time permitted.

The meetings were conducted with dispatch and promptness and adjourned at scheduled times. All papers were presented as announced except M38, M44, M48, and M51.

Mr. Herzer appointed a nominating committee consisting of: O. F. Garrett, T. B. Harrison, and H. Macy, to nominate a vice-chairman and a secretary for the coming year.

Considerable interest was shown in the reports of the various committees. These reports follow:

Reports of committees:

1. Committee on Chemical Methods for the Analysis of Milk and Dairy Products, L. C. THOMSON, *Chairman.* Accepted and written report attached.
2. Committee on Judging of Dairy Products, G. M. TROUT, *Chairman.* Accepted and written report attached.
3. Committee on Methods of Determining the Curd Tension of Milk, F. J. DOAN, *Chairman.* In the absence of any member of the committee this report was not presented; however, the written report was received and is attached.
4. Deleted.
5. Committee on Sanitary Procedure, L. H. BURGWALD, *Chairman.* Accepted and written report attached.
6. Committee on Methods of Measuring the Color of Milk, O. F. GARRETT, *Chairman.* Accepted and written report attached.
7. Committee to Study Methods for Measuring the Oxidation of Milk Fat, O. F. GARRETT, *Chairman.* Accepted and written report attached.
8. Committee on Quality Program, W. H. E. REID, *Chairman.* Accepted and written report attached.
9. Methods for the Bacteriological Analysis of Milk and Dairy Products, H. MACY, *Chairman.* Accepted and written report attached.

   Upon the motion of the committee chairman, the Section voted that the committee on Methods for the Bacteriological Analysis of Milk and Dairy Products be discharged and that a new committee of three, designated "The Committee on Microbiological Methods for the Analysis of Milk and Dairy Products," be appointed and that such committee be empowered to appoint such sub-committees as may be necessary to carry on the work of the committee.
10. Committee to Study Ways for Improving Summer Meetings of Manufacturing Section, B. E. HORRALL, *Chairman.* Accepted and written report attached.

Initiated by M. E. Parker, there was considerable discussion about the type of program which should be presented at the Section meetings. The report of the Committee to Study Ways for Improving Summer Meetings of the Manufacturing Section was called for and presented by B. H. Horrall, Chairman. The Committee made three recommendations:

1. That mimeographed sheets be used for the presentation of data in preference to photographic slides.

2. That speakers be requested to speak extemporaneously rather than to read a prepared manuscript.

3. That the first and last paper on the program at each meeting be of the symposium type.

The sentiment of the Section as expressed by vote was favorable to a program in which a portion of the time be allotted to papers of the symposium type, a portion to the short type paper and a portion to committee reports. The Section voted to appoint a rotating committee to have charge of formulating programs for the summer meetings.

Mr. Herzer instructed the Committee to Study Ways for Improving Summer Meetings of the Manufacturing Section to meet with the Association Board of Directors to consider the desirability of and means to be used in changing the type of program presented by the Manufacturing Section.

After conferring with the Association Board of Directors this committee reported to the Section as follows:

The Board of Directors of the American Dairy Science Association passed a motion last night to recommend to the sections of the Association that:

The program next year consist of the following:

(1) General papers
(2) Symposia, and
(3) Committee reports

The report of the Committee was accepted by vote of the Section.

The nomination committee placed the following names in nomination for officers for the year October 1, 1940, to September 30, 1941:

Vice-Chairman—L. H. BURGWALD	W. H. E. REID
Secretary—H. C. MOORE	E. O. ANDERSON

A vote by ballot was taken, the secretary, O. F. Garrett, T. B. Harrison, and H. Macy acted as tellers. Mr. C. D. Dahl, present Vice-Chairman, automatically becomes Chairman of the Manufacturing Section.

The following officers were elected: *Vice-Chairman*—L. H. BURGWALD, *Secretary*—E. O. Anderson.

Business session adjourned.

(Signed) S. T. COULTER
Secretary, Manufacturing Section

Extension Section

Mr. Vergeront, Secretary of the Extension Section, presented the following report which upon motion duly seconded was accepted and ordered to be printed in the minutes:

The annual business meeting of the Extension Section was called to order by R. G. Connelly, Chairman, June 26, at 1:30 P.M.; 36 others in attendance from a total of 28 different states.

During the two-day session, selected papers and reports on various phases of the extension program were presented and were discussed by the

members, led by a panel made up of members who had participated in the program.

The Resolution Committee presented the following resolution:

Resolved, we wish to express the sincere appreciation of the Extension Section to Purdue University and especially to each and every member of the Dairy Department, who have done so much to successfully prepare for our comfort and enjoyment.

C. R. GEARHART
E. H. LOVELAND
JAMES W. LINN

James Linn, Chairman of the Type Classification Committee, presented a progress report which was favorably accepted, but held over to be again presented to the 1941 meeting after further study by the committee.

E. J. Perry, Chairman of the Sire Committee, presented the report for that group. Each section was taken up separately and discussions for the matter of selective registration and the use of standard forms for artificial breeding association were commended.

Upon the motion of C. G. Bradt of New York a new committee on Dairy Cattle was established.

The Health Report of a joint committee of the Production and Extension sections of Feeding was made by Professor E. S. Savage, Chairman, and was unanimously adopted.

The members of this section expressed themselves as being very much pleased with the Joint Session with the Production Session on Artificial Breeding, and with the Exhibit of Ideas and with the Panel Discussions which were a part of every program of the section.

During the business session of the section, J. F. Kendrick, of the Bureau of Dairy Industry, was elected Secretary. The officers who will assume their responsibilities on October 1, 1940, are as follows:

Chairman—OTTO J. HILL, Pullman, Washington
Vice-Chairman and Chairman of the Program Committee—
GLEN W. VERGERONT, Madison, Wisconsin
Secretary—J. F. KENDRICK, Washington, D. C.

Respectfully submitted,

(Signed) GLEN W. VERGERONT
Secretary, Extension Section

Production Section

Mr. H. A. Herman, Secretary of the Production Section, presented the following report and upon motion duly seconded it was accepted and ordered to be printed in the minutes:

The production section held five regularly scheduled sessions. The first

session, Tuesday afternoon, June 25, was a combined meeting of the production and extension sections and consisted of a symposium on artificial insemination of dairy cows. The remaining formal sessions were devoted to papers grouped under sectional headings of: Milk Secretion, Breeding, Disease, Calf Feeding, and Nutrition, Minerals and Vitamins. Dr. A. H. Kuhlman presided at all sessions.

All sessions were well attended and much interest was exhibited in the papers presented. The papers were well prepared and ably presented with slides and mimeographed material used to supplement the presentation. Fifty-six papers were presented, a record number, as all but two of the 58 scheduled papers were presented. The marked program, attached, indicated the member presenting each paper.

The business meeting of the section was held at 8:30 A.M., Thursday, June 27, in Room 340, Purdue Memorial Union Building, with about 100 members in attendance. Dr. A. H. Kuhlman, Chairman, presided. The minutes of the 1939 meeting at Pullman, Washington, were read and approved.

Reports were submitted by the various standing committees and approved. Copies of these reports attached.

Points of particular interest incorporated in the adopted reports and presented to the general business session for approval are:

Breeds Relation Committee—J. W. BARTLETT, N. J., *Chairman*

1. The present specified numbers of milkings (36) to be supervised daily for cows on Advanced Registry Test should not be increased. It is the obligation of the supervising institution to enforce this rule.

2. No changes in the Uniform Herd Test Forms are recommended at this time.

3. The preliminary milking shall be weighed, sampled and tested for butterfat in the usual manner. The preliminary milking shall constitute a regular milking period with respect to the number of milkings supervised daily.

4. Supervisory institutions in the respective states, not in harmony with breed associations rules more lax than the Uniform Rules may well use the Uniform Rules as a basis for conduct of Advanced Registry and Herd Improvement Registry Tests.

5. To revise and bring up to date the Uniform Rules of the Association concerning the conduct of Advanced Registry and Herd Improvement Registry Testing and to have these printed in the JOURNAL OF DAIRY SCIENCE with sufficient extra copies for breed associations and supervision institutions. It is further recommended that the breed associations print the uniform rules in their rule booklets.

6. "If a cow on Advanced Registry or Herd Improvement Registry test

aborts while in milk, and the gestation is 152 days or longer, her current record shall end and a new lactation shall begin, but if the abortion occurs at less than 152 days the test is to be continued to complete the 305 or 365 day test."

7. The matter of compiling a uniform set of age conversion factors is being investigated further through the cooperation of the Bureau of Dairy Industry, United States Department of Agriculture.

8. The problem of working out a plan of Dairy Herd Improvement Association Type classification is continued with the Breeds Relations and Extension Section committees cooperating.

9. "That the American Dairy Cattle Club be permitted to use the Uniform Head Improvement Registry Test Form, but that only the names of the breeds of dairy cattle recognized in the purebred dairy cattle registry associations be printed on the form."

10. Supervisors conducting official tests should conform to the same requirements with respect to health certificates as is required of all milk handlers in accord with the provisions of the Standard Milk Ordinance, United States Public Health Service.

11. That close cooperation be maintained between the Breeds Relations Committee and the respective dairy cattle breed associations with respect to the uniformity of registering offspring resulting from artificial insemination.

12. That all, except current records of the Breeds Relations Committee be bound and filed with the Secretary of the American Dairy Science Association, as a part of the productions sections records, for safe keeping.

In view of the large number of papers presented and the inadequate time for business matters it was recommended and approved that this section go on record as being favorable to preparation of the program for the Production Section, and that the program be arranged, if necessary, in sections running concurrently, and that more time be provided for business meetings.

Committee on program to consist of Production Section Chairman and Secretary, and one member to be appointed by the chairman, but so appointed that the committee is continuous in operation, and only one new member be appointed each year.

All Standing Committees were reappointed with their present personnel except as follows:

Breeds Relations Committee, W. W. Yapp of Illinois appointed for a period of three years to succeed J. W. Bartlett, and H. A. Herman, serving unexpired term for Earl Weaver, appointed for three years, W. T. Crandall, Cornell, appointed chairman.

A. A. Borland, chairman of the Nominating Committee, presented names for offices of Vice-Chairman and Secretary of the Section for 1940. H. A. Herman, Missouri, was elected Vice-Chairman, and K. S. Morrow, New

Hampshire, was elected secretary. W. E. Petersen of Minnesota, Vice-Chairman 1939–40, automatically becomes chairman for 1940–41.

Respectfully submitted,

(Signed) A. H. KUHLMAN, *Chairman*
H. A. HERMAN, *Secretary*

Mr. Horrall, Chairman of the Program Committee, presented the following report which, upon motion duly seconded, was accepted:

The Program Committee for the 35th Annual Meeting of the American Dairy Science Association consists of F. H. Herzer, Mississippi State College, T. S. Sutton, Ohio State University, E. V. Ellington, State College of Washington, A. H. Kuhlman, Oklahoma A. and M. College, R. G. Connelly, Virginia A. and M. College, and B. E. Horrall, Purdue University, Chairman.

The first call for titles for papers was made January 4, 1940, in a letter addressed to the heads of Dairy and Animal Husbandry Departments, Bureau of Dairy Industry and Secretaries of large Associations. A call for abstracts was made in the January, February, March, and April numbers of the JOURNAL OF DAIRY SCIENCE. All abstracts were due to be in the hands of the Program Chairman on or before April 15, 1940, to be included in the program.

Six abstracts were received after the deadline of April 15. These were immediately sent back to the authors with our regrets that the abstracts were received after the deadline set by the committee.

There were received before and on April 15, 126 abstracts, and they were distributed as follows: Manufacturing, 51; Production, 58; and Extension, 17.

(Signed) B. E. HORRALL
Chairman

Resolution Committee

Mr. Ragsdale, Chairman of the Resolution Committee, presented the following report, which, upon motion duly seconded, was accepted:

The American Dairy Science Association assembled in its 35th annual meeting at Purdue University wishes to express its appreciation for the hospitality, delightful entertainment, and splendid facilities provided by the officials and faculty of that University.

Therefore, be it *Resolved:* That the membership of the Association publicly express its sincere appreciation to President E. C. Elliott; H. J. Reed, Dean and Director; Professor H. W. Gregory, and members of the departmental staff; A. P. Stewart, Director of Music, all of Purdue University, and to all agencies and organizations which cooperated with them in providing programs and entertainment, and in extending so many fine courtesies.

WHEREAS, the American Dairy Science Association feels that it is an inspiration to all and especially to the younger members to have the presence of those who have been long associated with this association:

Therefore, be it *Resolved:* That we note with appreciation the great regularity of attendance of W. J. Frazier, C. C. Hayden, O. F. Hunziker, and E. S. Guthrie, charter members; J. F. Frandsen, founder of the JOURNAL OF DAIRY SCIENCE, and those whom the association has seen fit to give honorary recognition because of long and exceptional service and leadership; namely, W. J. Frazier, O. F. Hunziker, M. Mortensen, and J. F. Frandsen.

The American Dairy Science Association also wishes to express its appreciation to the Borden Company for its continued interest in dairy research as indicated by its continuing awards for superior research in dairying and related fields.

The American Dairy Science Association would like finally to express its appreciation to the members of the program committee who have been responsible for the organization of one of the finest programs ever presented. The members of this committee being F. H. Herzer, T. S. Sutton, E. V. Ellington, A. H. Kuhlman, R. G. Connelly, and B. E. Horrall, Chairman.

Submitted by
G. A. BOWLING
H. A. HARDING
C. C. HAYDEN
C. A. IVERSON
A. C. RAGSDALE, *Chairman*

Mr. Borland reported for Mr. Brueckner, Chairman of the Committee on the Time of Meeting, and the report will be found in the minutes of the Board of Directors.

Mr. Boxell, Chairman of the Registration Committee, reported the following:

The 1940 figures represent a total of 715 men, women, and children. Of the 480 men, approximately 388 registered as active members. 140 were listed as representatives of commercial concerns. This is only a preliminary report. The above figures are believed to be a trifle high. A complete and verified report will be submitted to the secretary at the earliest possible moment.

(Signed) K. C. BOXELL

The Secretary then gave the summary of his report.

The policy of this association is to have the Board of Directors handle most of the business of this association. However, it is the opinion of the Board that all reports that have been accepted by the Board of Directors should also come before this business session so that the membership will know as early as possible the action that the Board has taken. A copy of

the Certified Public Accountant's Audit was made last January 25 and mailed to each of the Board of Directors. I will not burden you with the details of this report but I should like to compare for you the income of 1935 with 1939. In 1935 it was $7,873 and last year it was $17,572. The report of the auditing committee was then read. See meeting of Board of Directors.

This year we are publishing 2800 journals each month instead of 2500. The Board of Directors have recently authorized the expenditure of almost $900 to reproduce nine different numbers of the JOURNAL, including all six numbers of Volume I. Our circulation in 1939 was 2,438. We had 1465 members; 706 subscribers; 73 associate subscribers and 156 affiliates. This year we have taken in 50 new members. Illinois is leading the list with 10; Ohio, 5; New Jersey, 4; California, Indiana, and Minnesota, 3 each; Mississippi, Montana, Pennsylvania, Utah, Wisconsin, 2 each; and those having one are Alabama, Arizona, District of Columbia, Iowa, Kentucky, Louisiana, Massachusetts, New York, South Dakota, Texas, Vermont, and Quebec.

This year President Guthrie appointed a membership committee and most of the efforts were in the direction of stressing the student affiliates. Last year we had 156, and this year thus far we have a total of 247. Iowa led the states with 47 affiliates, Ohio, 34; Illinois, 19; Washington, 16; Wisconsin, 13; Pennsylvania, 12; South Carolina and Texas, 11; New York and Virginia, 10; Indiana, 8; Massachusetts, 7; Connecticut, 6; Maryland, Michigan, Minnesota, 5; California, Missouri, Nebraska, and Tennessee, 3; Idaho, Oregon, Kentucky, and Vermont, 2; Georgia, Kansas, Montana, New Hampshire, New Jersey, Oklahoma, South Dakota, and West Virginia, 1.

The minutes of the Board of Directors were then read.

Upon motion duly seconded the minutes of the Board of Directors were accepted and the association approved and endorsed all action that the Board had taken during the past year. The Secretary then called their attention to the change in the By-laws made at the business meeting yesterday at 4:00 P.M. The section 3, Article 5 was amended to read as follows:

Amendment of Section 3, Article 5.

The present section reads as follows: "Section 3—the Quorum of any meeting of the Association shall consist of not less than ten per cent (10%) of the membership."

We propose to amend this section to read five per cent (5%) in lieu of ten per cent (10%) so that section 3 will read as follows:

"Section 3—the Quorum of any meeting of the Association shall consist of not less than five per cent (5%) of the membership."

Back copies of the Journal are now available. It has been suggested that each investigator see whether or not your library has all the back copies of the Journal. They are now procurable from the secretary's office, price

$5 per Volume up to 1933, $6 per Volume since 1934. Single copies may be procured at $1 each.

The report of the Journal Management Committee was then read. For this report see the minutes of the Board of Directors meeting.

Mr. Ellenberger then gave the following report of the Committee on Dairy Curricula:

Speaking for the general committee, I may report that much work has been done by way of collecting and tabulating for study: (1) The objectives of all colleges offering curricula in agriculture and of departments in which students may take majors in any line of dairying, and (2) the individual courses offered in each curriculum.

The existing variations as regards objectives, conditions, and facilities in the different states have been found to be so great that more detailed study must be made. Such study involves much work and time but progress is being made as rapidly as possible.

Lengthy, well-attended committee sessions have been held here at Purdue resulting in much unanimity of opinion. Before the submission of recommendations to this body as to minimum subject matter requirements and curricula it has been decided that certain sub-committees should be set up to make detailed studies and suggestions as to minimum subject matter (not course) requirements in each of the following fields:

For both Production and Manufacturing:
- Chemistry
- Mathematics and Physics
- Bacteriology
- English and Public Speaking
- Economics and Business

Recommended Electives

For Production:
- Biological science including Genetics
- Veterinary subjects as Anatomy, Physiology, Hygiene, and Pathology
- Dairy Production subjects including Nutrition and Feeding, Agricultural Engineering and Mechanics

For Manufacturing:
- Dairy products manufacturing subjects
- Dairy mechanics
- Subjects providing an agricultural background

Committees are to be appointed promptly to consider all these subjects and report their findings by January 1, 1941. After existing committees have considered such reports in connection with other studies they are making, it is expected that an extended mimeographed statement, including rec-

ommendations will be submitted to all members previous to or at our next annual meeting.

The committee has taken cognizance to the facts that (1) there are three divisions of work in our land grant colleges, teaching, research, and extension, (2) the latter two are well provided for in the programs for our annual meetings and (3) this group, though originally organized as the Official Dairy Instructors Association now gives scant consideration in its programs to problems associated with teaching. After conferring with numerous association members and finding seeming unanimous approval this committee hereby requests that the president as chairman of the program committee appoint a committee of three to (1) prepare and submit a program on in-instruction for at least a one-half day session at our next annual meeting, to run concurrently with programs of the now established sections, and (2) bring before those who may attend that session a proposal for the establishment of a teaching or instruction section, said committee members to act as officers of the unorganized group for the coming year.

Respectfully submitted,

(Signed) H. B. ELLENBERGER

Chairman

Mr. C. E. Wylie then gave his report on the Curriculum on Production:

The committee has continued its study of dairy production curricula according to the progress report made at the American Dairy Science Association meeting at Washington State College, June 30, 1939.

1. The committee has initiated a special study of elementary dairy instruction which has been referred to the General Curriculum Committee and is being handled by C. E. Wylie and H. P. Davis.

2. The committee has divided its work and made assignments as follows: Objectives in teaching, C. Y. Cannon—Fundamental courses, I. R. Jones—Required dairy and agricultural courses, J. W. Bartlett—Elective courses, Chas. N. Shepardson—Relation of dairy manufacturing courses to dairy production courses, T. E. Woodward.

3. The committee recommends that several papers be presented on the following subjects at the next annual meeting of the association, and that not less than one-half day be devoted to dairy instruction.

a. Methods and materials in teaching dairy husbandry—3 papers.

b. Curriculum construction.

c. Testing and Revising a Curriculum.

Committee: J. W. BARTLETT, I. R. JONES, C. N. SHEPARDSON, T. E. WOODWARD, C. Y. CANNON, W. L. CLEVENGER, and C. E. WYLIE, *Chairman*.

Mr. Mortensen submitted the report signed by Mr. Roadhouse on the Curriculum on Manufacturing.

In continuing the work of the subcommittee on Dairy Manufacturers Curriculum during the present year, a copy of the last annual report was sent to all Dairy Departments with a request for comments. The report emphasized that an effort should be made to develop greater uniformity of dairy manufactures curricula which include sound basic training in order to give a good general education. The report also covered two points of view concerning the curriculum in Dairy Manufactures.

1. That there should be a special curriculum for students majoring in Dairy Manufactures.

2. That there should be one curriculum that would serve both manufacturing and production field in basic training and allow a liberal choice of electives to serve the needs of students specializing in the separate fields.

Dairy Departments of 24 states have responded. After analyzing these replies it appears that in those states where dairy manufacturing is less specialized a combined curriculum for both dairy production and dairy manufacturing is favored; in other colleges a separate curriculum for dairy manufacturing is preferred. The replies indicate that the instruction offered at the different colleges in applied subjects is adequate for the conditions that exist in the individual states. The greatest difficulty occurs when students wish to transfer their credits to other institutions. These students often find themselves handicapped by not having the necessary prerequisites for upper division and graduate instruction.

It is recognized that the demands of the dairy industry in the different states make difficult the adoption of a uniform curriculum. This applies to the policies of the universities and colleges of the different states. With these conditions in mind, it seems desirable that this study be continued with a view to setting up two curricula, one for institutions where dairy productions and dairy manufacturing are combined in one department and serve both phases of dairying and a second in which a separate curriculum is recommended for those colleges where dairy manufacturing is taught in a separate department.

In spite of the difficulty of setting up a curriculum uniform in all particulars it is recommended that curricula be made uniform with respect to minimum basic requirements. The committee is proceeding to develop recommendations for outlines of minimum requirements in basic courses and whether there should be different requirements for Manufacturing than for Production.

(Signed) C. L. ROADHOUSE, *Chairman*

The Nominating Committee made the following report:

For *Vice-President:* H. F. JUDKINS, New York; J. A. NELSON, Montana
For *Directors:* H. B. ELLENBERGER, Vermont; C. E. WYLIE, Tennessee; KENNETH N. RENNER, Texas Tech.; A. C. DAHLBERG, Geneva

Committee:
J. H. FRANDSEN
(H. G. Lindquist, acting for Frandsen)
T. B. HARRISON
RANDALL WHITAKER
J. A. NEWLANDER
H. W. GREGORY

The Nominating Committee stated that inasmuch as the Association now had 1,465 members made up of approximately 125 men from institutions connected with dairy manufacturing and 140 men from institutions connected with dairy production and 820 men from industries, the committee wishes to submit the name of a man connected with the industries and who was formerly connected with an educational institution.

Honorary Member

At the banquet on Thursday night, President Guthrie introduced Mr. Ellenberger who said:

In years past this association has paid honorary tribute to three of its members who, with their wives as partners, and not silent partners either, have rendered outstanding service to our association and to the dairy industry. I am requesting them to rise so that all, particularly the younger persons, may know them by sight as well as by reputation.

Professor William J. Fraser of Illinois, the founder of our organization, was presented a framed "token of appreciation" in 1933 for his "clear vision of the possibilities in advancing the cause of scientific dairying through a closer organization of the workers in the field" and for eminent service to the industry.

Dr. Otto F. Hunziker of Chicago was presented a similar "tribute" in 1934 for "outstanding leadership in dairy research and education" and in association affairs.

Dr. Martin Mortensen of Iowa was given, in 1935, a framed "tribute" in recognition of his "eminent service to the dairy industry . . . and his devotion to our association."

Now, five years later, in 1940, and in accordance with the decision of the awards board comprised of the three most recent past presidents, we are to honor and present a tribute to another of our members, Professor Julius H. Frandsen of Massachusetts.

Professor Frandsen was born in Story County, Iowa, the central county of the central state of the cornbelt. He was raised on a farm and has been associated with dairying in one form or another all of his life. He is a graduate of Iowa State College in the class of 1902, where I was a student with him and from which he received a Master of Science degree in 1904. In 1906 Matilda Madison, another Iowa State College graduate, became his wife and a very active life partner.

From 1904–1907 Professor Frandsen was engaged in commercial work for Professor Mortensen. In 1907 he was appointed the first Professor of Dairy Industry at the University of Idaho, where he remained as head of the department until 1911 when he became Professor of Dairy Husbandry at the University of Nebraska. While there he was instrumental in securing the erection of the dairy building, dedicated in 1917, then recognized as the finest building for college dairying in the country and still ranking as one of the best.

Leaving the University of Nebraska in 1921 to become dairy editor of farm papers, he again returned to teaching and research in 1926 as Professor of Dairy Industry at the Massachusetts State College, the position which he now holds.

Professor Frandsen served as president of the Official Dairy Instructor's Association, as this organization was then named, during 1913 and 1914. In his presidential address of 1913 he made a strong plea for the establishment of a Journal to be published by our association in the interest of dairy science and research. From that time through 1914–1916, he at every opportunity advocated the establishment of such a Journal. This ambition was realized, when at its 1916 annual meeting, this association approved the establishment of the JOURNAL OF DAIRY SCIENCE and designated Professor Frandsen as Editor-in-Chief. It is interesting to note that this action was taken in Flint Laboratory, Amherst, Massachusetts, the building in which Professor Frandsen now has his office.

As editor of the JOURNAL OF DAIRY SCIENCE from May, 1917, to January, 1928, Professor Frandsen has been the means of arousing, encouraging, and advancing dairy research in a way and to an extent now recognized as outstanding and important.

We are sorry that, because of illness, Professor Frandsen cannot be here tonight, but I am pleased to read the framed tribute which our president, Dr. E. S. Guthrie, will forward to him.

JULIUS HERMAN FRANDSEN

DAIRYMAN

TEACHER, INVESTIGATOR, AND EDITOR

In recognition of outstanding service to dairy science in America, particularly in the conception, advocacy and establishment of the JOURNAL OF

DAIRY SCIENCE, which he so carefully nurtured and successfully edited and managed for eleven years, a substantial and far-reaching contribution of inestimable value to the advancement of dairy research, teaching, and practice, the American Dairy Science Association at its thirty-fifth Annual Meeting at LaFayette, Indiana, this twenty-seventh day of June, one thousand nine hundred and forty, honors Professor Julius Herman Frandsen and presents this tribute.

R. B. STOLTZ,
Secretary

E. S. GUTHRIE,
President

MEETING OF BOARD OF DIRECTORS AMERICAN DAIRY SCIENCE ASSOCIATION

R. B. STOLZ
Secretary-Treasurer

8:00 P.M., *June 24, 1940*
West Lafayette, Indiana

A meeting of the Board of Directors of the American Dairy Science Association was held in the Memorial Union Building, Monday, June 24, 1940, at 8:00 P.M.

Present: President E. S. Guthrie; Vice-President H. W. Cave; Secretary-Treasurer R. B. Stoltz; Directors, Harold Macy, J. W. Linn, E. V. Ellington, M. E. Parker, C. N. Shepardson, Fordyce Ely.

Absent: Director, Earl Weaver.

President Guthrie called the meeting to order.

Mr. O. F. Hunziker, Chairman of the Journal Management Committee, submitted the following report:

Your Committee on Journal Management beg to respectfully submit the following brief report:

Financial: The income and outgo related to the business operation of the JOURNAL OF DAIRY SCIENCE are given in detail in the Auditor's report for the year 1939, which shows a most gratifying increase in the net revenues of the JOURNAL, and copy of which was mailed to every member of the Board by the Secretary-Treasurer.

Twenty-Year Index of Journal: At last year's Annual Meeting your Committe recommended the preparation of an index covering the first 20 volumes of the JOURNAL OF DAIRY SCIENCE; we likewise suggested tentative arrangements and terms dealing with the actual work of indexing.

Your Board approved the general idea of the desirability of such an index and referred the matter back to the Committee and editor for further investigation as to definite arrangements to get the work done, with instructions to report our findings back to the Board. This was done. The Com-

mittee was fortunate in securing the services of Dr. H. Macy to take charge of the index work under the terms stipulated in our original recommendation. The Board approved our proposed arrangement and the job of indexing was turned over to Dr. Macy. The author index has been completed and the subject index is in the process of preparation.

Reproduction of Back Journals: In order to take care of orders for back numbers of the JOURNAL, the Journal Management Committee recommended to President Guthrie that a sufficient sum be set aside for the reproduction of such back numbers of the JOURNAL as are out of print. There are nine numbers of the JOURNAL that are either entirely exhausted or of which only a few copies are left. Reproduction of these nine numbers will involve an approximate cost of $870.00. This recommendation has been approved by the Board, authorizing the Secretary-Treasurer to utilize the necessary amount (not in excess of $1,000.00) for this purpose.

Length of Review Articles: The proper control of the length of Review Articles has developed into somewhat of a problem. You may recall that, upon the joint recommendation of the editor and this Committee, the Board approved in substance the following ruling on size of manuscripts acceptable for publication in the JOURNAL.

1. That manuscripts be limited, as far as possible, to twelve printed pages.

2. That the cost of pages in excess of twelve be charged to the author on the basis of $5.00 per page.

3. That, in the case of manuscripts of unusual merit, no charge be made for pages in excess of twelve.

The above ruling was established prior to the advent of soliciting Review Articles for publication. It appears obvious from the very purpose and the consequent nature of review articles, that the above ruling on page limit should not be expected to apply to these special articles. These articles cannot be consistently limited to any such page limit, nor perhaps to any arbitrary page limit.

However, experience with unduly long review articles suggested the advisability of providing some means to avoid receipt for publication of Review Articles of unreasonable length. It is our unanimous opinion that an approximate length of 25 printed pages may well be considered ample in most cases. In addition, we feel that it may prove helpful to the author and may be welcomed by him to mention to him, at the time the subject is assigned, the JOURNAL's conception of an approximate desirable page limit.

At the same time, we consider undesirable any ruling that might embarrass authors of review articles by any set page limit, and we hold that the most effective and acceptable control of the article-size must lie in the judicious selection of the subject and of the author. It is, therefore, by

PROFESSOR H. W. CAVE, PRESIDENT-ELECT

efforts along these lines that we hope to accomplish satisfactory control of the page limit of review articles.

Reorganization of Abstract Service: The preparation of plans for the early reorganization of the Abstract Service is now in progress. The purpose is to make this service more complete and to improve its quality. There appears to be too much delegation of responsibility, too unwieldy an organization. We need fewer but more really conscientious abstractors.

Control on the part of those in authority has been inadequate apparently largely because of the total absence of any financial consideration for this work. Your Committee respectfully recommend, therefore, that the problem of compensating for abstract editors and abstractors be given serious consideration by the Board and that definite action be taken at this meeting.

Respectfully submitted by

The Committee on Journal Management

A. A. BORLAND,
R. B. STOLTZ,
O. F. HUNZIKER, *Chairman*

Mr. Ellington moved and Mr. Macy seconded that the report be accepted.

Editor T. S. Sutton was then called upon, and presented the following report:

Your Editor begs to submit the following brief report:

1. Summary of Journal Contents.

During the past year, July, 1939, to May, 1940, inclusive, the JOURNAL OF DAIRY SCIENCE has carried 97 papers exclusive of the proceedings of the annual meeting, announcement material, necrologies, membership and circulation lists and abstracts. These 97 papers occupied 945 pages.

A classification of these papers shows that 53 papers covering 450 pages were devoted to manufacturing, 31 papers covering 296 pages to production and 10 papers occupying 80 pages were of basic interest to both divisions. In addition, three review articles have been published occupying 119 pages, also a special report of the Students' National Contest in Judging Dairy Products covering 4 pages.

During the same period 94 pages have been devoted to announcement material, proceedings 34th annual meeting, membership lists, index, etc., and 206 pages were occupied by abstracts of literature. This is 1245 pages in all. This does not include the June, 1939, issue which contains the program and abstracts of papers.

Obviously, it has been necessary to increase the JOURNAL size somewhat in order to accommodate all accepted material without falling farther behind in publication.

2. Origin of Contributions.

Last year we reported the origin of the papers for the year 1938 and 1939 only. In this report we felt it would be of interest to report the origin of papers which appeared in the JOURNAL from July, 1938, to May, 1940, inclusive.

During this two-year period papers have been published originating in 28 states, the United States Department of Agriculture, Canada and Hawaii. In addition, scientific papers prepared by two American Dairy Science Association Committees have been published. The number of papers from any one state has varied from 1 to 21 for the period. The number of contributions by states is shown in the accompanying table.

CONTRIBUTIONS BY STATES; JULY 1938–MAY 1940 INCLUSIVE

State	*Number Papers*	*State*	*Number Papers*
New York	21	South Dakota	3
Illinois	18	Arizona	3
Wisconsin	16	Idaho	2
Michigan	14	West Virginia	2
U.S.D.A.	13	Canada	2
Iowa	12	Florida	1
Minnesota	11	Hawaii	1
Pennsylvania	9	Montana	1
Kansas	8	Nebraska	1
New Jersey	8	Nevada	1
California	7	North Dakota	1
Oklahoma	6	Oregon	1
Ohio	5	South Carolina	1
Maryland	5	Virginia	1
Indiana	4	Washington	1
Committee reports	4	Massachusetts	1
Missouri	4		188

28 states, U.S.D.A., Committee reports, Canada and Hawaii.

3. Review Articles.

During the past year three review articles have been published. A fourth has been received and is scheduled to appear in the July, 1940, issue.

The published reviews have been well received. With a little special effort on our part, we were able to sell over 1,000 extra copies of the JOURNAL in which one of these reviews appeared.

Of those originally planned for, only a few are yet to be received. In view of this, a second group of reviews have been planned. The first of these probably will not be ready for the JOURNAL until sometime this coming fall.

In extending our invitation to these reviewers, we have suggested that the subject-matter field be limited in such a way that the review will not

be too lengthy, yet we insist that the literature within this restricted subject-matter field be completely covered.

4. The Twenty-Year Index.

The preparation of a 20-year index is under way. The author index covering the first 20 volumes has been received.

5. A Style Standard for Preparing Manuscripts.

A committee appointed by President Guthrie is working on this important project. We trust that we will shortly have a report from this committee to serve as a helpful guide in the preparation and editing of manuscripts to be published in our JOURNAL.

6. The Abstract Section.

In certain areas this work has been and continues to be highly commendable; in others, the work of abstracting has been neglected. A large number of those listed as abstractors have submitted no abstracts during the past year. A number of journals have not been abstracted.

The proposed plan of reorganization embodies the following points:

a. Reorganization of the abstract editorial board.

b. Reducing, by about one-half, the number of abstractors.

c. Reallotment of those journals not regularly abstracted. It may be advisable to drop certain journals which do not carry articles of interest to the industry.

d. Have special publications (Experiment Station Bulletins, leaflets, circulars, etc.) mailed direct to the editor's office. These will then be submitted to the abstract editor in whose subject-matter field they lie, for abstracting.

To support and strengthen a feeling of responsibility to the JOURNAL, and as an acknowledgment of the services rendered to the JOURNAL, we recommend that the Board of Directors take favorable action on the suggestion of the Journal Management Committee regarding compensation of abstract editors and abstractors.

Again we want to take this opportunity to address a word of appreciation to all of those who have given so generously of their time and efforts in assisting with the editorial work. Without this loyal support the task of managing the editorial affairs of the JOURNAL would present an impossible problem. In particular, we wish to thank: the Journal Management Committee for their wise council and helpful suggestions, the editorial board and others who have reviewed manuscripts, and the abstract editors and abstractors for their generous contributions. To all of these and others we are grateful. To them should go the credit for any measure of success attained.

Respectfully,

T. S. SUTTON, *Editor.*

Mr. Ely moved and Mr. Parker seconded the acceptance of the report.

A letter from Mr. G. Bohstedt was read concerning our Association contributing towards the financial support of Biological Abstracts. It was moved by Mr. Macy and seconded by Mr. Ellington that the letter be referred to the Journal Management Committee for recommendation.

It was moved and seconded that the Secretary submit a proposed budget as suggested by past editor Dahlberg.

It was moved by Mr. Cave and seconded by Mr. Macy that the Eastern Division be allotted $15.00 in addition to the usual $25.00 to meet their expenses for this year, and that a committee of three directors be appointed to make a study and to investigate the need for our Association in supporting the Divisions, and to define the geographical limits of the Divisions and report back to the Board of Directors. The committee appointed is as follows:

J. W. LINN, *Chairman*
E. V. ELLINGTON
FORDYCE ELY

Upon motion, duly seconded, the meeting was adjourned to meet in this room at 4:00 P.M. on Tuesday, June 25.

MEETING OF BOARD OF DIRECTORS AMERICAN DAIRY SCIENCE ASSOCIATION

4:00 P.M., *June 25, 1940*

A meeting of the Board of Directors of the American Dairy Science Association was held in the Memorial Union Building, Tuesday, June 25, 1940, at 4:00 P.M.

Present: President E. S. Guthrie; Vice-President H. W. Cave; Secretary-Treasurer R. B. Stoltz; Directors, Harold Macy, J. W. Linn, E. V. Ellington, M. E. Parker, C. N. Shepardson, Fordyce Ely.

Absent: Director, Earl Weaver.

The minutes of the Monday evening Board meeting were read and approved. The Secretary-Treasurer had previously sent a report of the Certified Public Accountant, giving an itemized list of receipts and expenditures, to each member of the Board of Directors. This report had been referred by the President to an auditing committee.

May 20, 1940

To the Members of the American Dairy Science Association
Gentlemen:

Mr. Walter C. Burnham, of Columbus, Ohio, Certified Public Accountant, has made an audit and report of the financial condition of the Association as of January 1, 1940. The Auditing Committee has conferred with Mr. Burnham and is satisfied that he has made a careful examination of all the assets and liabilities of the Association and that all the accounts are accurate. The committee is satisfied that the

balance sheet and related summary of profit and loss fairly represents the financial condition of the American Dairy Science Association.

Respectfully submitted,
J. F. Lyman (Signed)
I. R. Krill (Signed)
W. L. Slatter (Signed)
Auditing Committee
American Dairy Science Association

Mr. Shepherdson moved and Mr. Linn seconded that the proposed budget as submitted be approved.

A communication was read from a direct advertising and sales promotion company, and upon motion by Mr. Macy and seconded by Mr. Ellington, the matter was laid on the table.

The committee, consisting of Mr. H. J. Brueckner, Chairman, and Mr. A. A. Borland, appointed by President Guthrie to study the result of the questionnaire pertaining to changing the time of the annual meeting reported as follows:

It is the opinion of your committee, as a result of studying the replies from the various institutions to the questionnaire sent by Secretary Stoltz on September 7, 1939, that the latter part of June is the most satisfactory time for holding the annual meetings of the American Dairy Science Association and that if agreeable to the host institution, the meetings be held the last week in June in order to give the men from a few of the schools a little more time to get to the meetings.

Members of Committee
A. A. BORLAND
H. J. BRUECKNER, *Chairman*

The report of the committee was accepted, and it was the consensus of opinion of the Board that they preferred the time of meeting to be held in Vermont to be the week of June 23.

The Board then adjourned to meet at 9:30 P.M.

MEETING OF BOARD OF DIRECTORS AMERICAN DAIRY SCIENCE ASSOCIATION

9:30 P.M., *June 25, 1940*

A meeting of the Board of Directors of the American Dairy Science Association was held in the Memorial Union Building, Tuesday, June 25, 1940, at 9:30 P.M.

Present: President E. S. Guthrie; Vice-President H. W. Cave; Secretary-Treasurer R. B. Stoltz; Directors, Harold Macy, J. D. Linn, E. V. Ellington, M. E. Parker, C. N. Shepardson, Fordyce Ely, Earl Weaver.

A petition was presented from the New York State School of Agriculture at Alfred, New York, petitioning to have a junior chapter of the American

Dairy Science Association. The Secretary was instructed to advise the School of the clause in the by-laws stating that student chapters may be formed in four-year agricultural colleges, and inasmuch as this agricultural school is a two-year course, they would be ineligible.

The Secretary was authorized to approve all other applications of student branches that conform with the regulations.

A communication was read from the Union of American Biological Societies. Upon motion duly seconded this was referred to the Journal Management Committee. The President was authorized to appoint a representative to the National Research Council.

Upon motion by Mr. Ely and seconded by Mr. Shepardson, the Secretary was instructed to enclose a suitable application blank for the Borden award in the letter that goes to the membership with ballots, the blank to contain a brief copy of the rules.

Mr. Weaver resubmitted the invitation from the Michigan State College for the Association to hold its annual meeting in 1942. Mr. Cave moved and Mr. Ellington seconded that the invitation be accepted.

Mr. Ely moved and Mr. Macy seconded that the Secretary be instructed to send the secretaries of the various divisions their allotment to spend as they see fit in the interest of the division meetings.

Mr. Shepardson moved and Mr. Weaver seconded that the President appoint a committee from the Board, one Board member to represent each of the three sections to go before the business meeting of the section on Wednesday afternoon at 4:00 P.M., and discuss with the sections the policies of their program, and request that the sections take action and appoint a rotating program committee to meet with the Board of Directors at 6:00 P.M. Wednesday. The following Board members were appointed: Mr. Cave to meet with the Production Section; Mr. Shepardson, the Extension Section; and Mr. Parker, the Manufacturing Section.

Upon motion duly seconded the Secretary was authorized to submit an amendment to our by-laws at the meeting Thursday afternoon at 4:00 P.M., changing the necessary attendance to make a quorum from ten per cent to five per cent.

Upon motion duly seconded the meeting was adjourned to meet again Wednesday at 6:00 P.M., the place to be designated on the bulletin board.

MEETING OF BOARD OF DIRECTORS AMERICAN DAIRY SCIENCE ASSOCIATION

6:00 P.M., June 26, 1940

A meeting of the Board of Directors of the American Dairy Science Association was held in the Memorial Union Building, Wednesday, June 26, 1940, at 6:00 P.M.

Present: President E. S. Guthrie; Vice-President H. W. Cave; Secretary-

Treasurer R. B. Stoltz; Directors, Harold Macy, J. W. Linn, E. V. Ellington, M. E. Parker, C. N. Shepardson, Fordyce Ely.

Absent: Director, Earl Weaver.

Invited Guests: Extension Section—O. J. Hill, G. E. Vergeront. Production Section—G. H. Wise, Glenn Salisbury and W. E. Petersen. Manufacturing Section—B. E. Horrall, P. A. Downs, P. S. Lucas. Also J. A. Nelson, H. B. Ellenberger, and H. W. Gregory.

Mr. Macy moved and Mr. Parker seconded that it be the recommendation of the Board that the program committee arrange for a program providing for:—

(1) symposia
(2) the presentation of original papers
(3) committee reports

Mr. Macy moved and Mr. Ellington seconded that it be recommended by the Board that the general program committee consist of the Retiring President, acting as chairman, and the chairman of the other three sectional program committees.

The Board then adjourned.

MEETING OF BOARD OF DIRECTORS AMERICAN DAIRY SCIENCE ASSOCIATION

5:00 P.M., *June 27, 1940*

A meeting of the Board of Directors of the American Dairy Science Association was held in the Memorial Union Building, Thursday, June 27, 1940, at 5:00 P.M.

Present: President E. S. Guthrie; Vice-President H. W. Cave; Secretary-Treasurer R. B. Stoltz; Directors, Harold Macy, J. W. Linn, E. V. Ellington, M. E. Parker, C. N. Shepardson.

Absent: Directors, Fordyce Ely and Earl Weaver.

The previous minutes of the Board of Directors were read and approved.

Mr. Shepardson moved and Mr. Parker seconded that the host institution and the division and sections be furnished Association letterheads for their official business.

Upon motion duly seconded the Board then adjourned.

AMERICAN DAIRY SCIENCE ASSOCIATION PRESENTED BORDEN AWARDS TO B. W. HAMMER AND C. W. TURNER

at the

ANNUAL BANQUET

Purdue Memorial Union Building
West Lafayette, Indiana, June 27, 1940

H. W. Gregory, toastmaster, made the following statement:

"Since 1936 we have had an award, which the American Dairy Science Association has prized very highly. The Borden Company, recognizing the valuable work of those working in the field of dairy science, has offered to the Association two annual awards of $1,000 in cash and a medal for meritorious scientific work in the field of dairy science. These awards are prized highly by the Dairy Science Association. We have a representative of the Borden Company here with us, and I would just like at this point for him to stand, and I will introduce him as W. A. Wentworth, of the Borden Company. It may be well for me to state the requirements for those who are eligible for this award. I would like to introduce the man who will present the recipient for the manufacturing award."

Mr. N. W. Hepburn:

"In the study of almost any important industrial development it early becomes apparent that practically all notable advancements in the field under observation can be traced to some individual working in a laboratory, with characteristic modesty, and often in relative obscurity.

"These findings become tools in industry's daily operations and sometimes little thought is given to their origin. It is indeed gratifying to find in our dairy industry, whose progress is marked with a similar pattern, an outstanding organization ready and willing to acknowledge indebtedness to individuals whose work has contributed measurably to its growth and success. The Borden Company has caught the vision of science's relation to industry and by means of its annual awards extends recognition for work well done. On this occasion, I think it fitting that we express our appreciation for the stimulus to research in dairying that is in this manner given.

"The American Dairy Science Association, on this, the thirty-fifth annual meeting very properly devotes a general session to commemorating the work of one of America's great dairy scientists, the late Dr. Babcock, who is remembered not alone for the contributions he made but as much for the inspiration he gave to his contemporaries and those who followed after him.

"Speaking of contributions and inspiration, tonight we are happy to participate in a program of giving special recognition to another beloved dairy

B. W. HAMMER

scientist—one who has fully earned the affection in which he is held—by his work, by his character, and by the leadership and inspiration he has given. The list of students who have made great strides—and particularly those who have received their Ph.D. degrees—under his leadership, is impressive, and we who have the good fortune to be counted among his friends cannot fail to realize that, with these great groups he has shared his lovable character and his inspiration as teacher and counselor. May his good work go on.

"Now we have come to the time, Mr. Wentworth, when it is my great pleasure to present to you, in behalf of the Committee on Awards, of the American Dairy Science Association, Dr. B. W. Hammer, to receive the 1940 Borden award in Dairy Manufacturing.

"The rules of the American Dairy Science Association require that the award be given for outstanding research in the field of dairy manufactures, the results of which have been published during the preceding five-year period.

"The list of candidates placed before the members of the Dairy Manufacturing Award Committee was impressive, indeed, and the Committee gave all the most careful consideration. Dr. Hammer, of the Iowa State College, was unanimously chosen for this honor.

"Dr. Hammer was born October 7, 1886, at Hillsboro, Wisconsin. After graduation from the Hillsboro High School in 1904 he entered the University of Wisconsin, graduating with the B.S.A. degree in 1908. He continued his studies at the University of Wisconsin under Dr. E. G. Hastings and was assistant in agricultural bacteriology in 1908–1909. He was then appointed bacteriologist, associated with Dr. M. P. Ravenel at the Wisconsin State Hygienic Laboratory, at the University of Wisconsin, from 1909–1911, after which he joined the Department of Dairy Industry at Iowa State College in 1911 and has since 1916 been chief in dairy bacteriology of the Iowa Agricultural Experiment Station and Professor of Dairy Bacteriology.

"Dr. Hammer was selected for this honor on his contributions including studies on the flavor and aroma constituents of butter and cheese, factors involved in the deterioration of butter, factors involved in the ripening of various cheeses, improvement in the methods for the manufacturing and curing of cheese, classification of microorganisms important in dairy products, action of various microorganisms on dairy products and development of new laboratory methods.

"Dr. Hammer's research has been both fundamental and practical. It is known, not merely throughout the United States, but in any country where dairying has been developed. Dr. Hammer is not merely known for his research—he is also recognized as one of the outstanding teachers in the Dairy Industry field and his textbook on dairy bacteriology is the

standard textbook not only in the United States, but also in many foreign countries.

Mr. Wentworth, I take great pleasure in presenting Dr. B. W. Hammer to you for the Borden Award."

Mr. W. A. Wentworth:

"Dr. Hammer, it gives me a great deal of pleasure to present to you this award on behalf of the Borden Company, and with it goes a slip of paper, which I am deeply happy to present."

Mr. Gregory, the toastmaster, then introduced Mr. S. I. Bechdel, of Pennsylvania State College, Chairman of the Production Awards Committee, who presented the recipient for the production award:

"In accordance with the regulations governing the Borden Awards adopted by the Board of Directors as reported in the August, 1939, issue of the JOURNAL OF DAIRY SCIENCE, it is the duty of the Award Committee in Dairy Production to select the person to be the recipient this year. The three members of this Committee gave careful consideration to the credentials of the nominees submitted by the Nominating Committee and have unanimously chosen Doctor Charles Wesley Turner, Professor of Dairy Husbandry, University of Missouri, Columbia, Missouri, to be honored with the award. The choice of Doctor Turner is based upon his outstanding and extensive fundamental research on the physiology and anatomy of the mammary gland. His fundamental work on the endocrinology of milk secretion has established new facts in this field and as a result he is receiving world-wide recognition. Although his research work along these lines has covered a twelve year period, the Committee would call attention to the fact that a total of 52 scientific papers, 10 scientific bulletins, 2 books, and 5 popular bulletins have been published under the authorship of Doctor Turner and his colleagues within the last five years. He has brought honor to himself and to the American Dairy Science Association through his untiring efforts to serve the industry in the field of Dairy Production. Mr. Wentworth, it is a real pleasure to present to you Doctor Charles Wesley Turner as the recipient of the Borden Award in Dairy Production."

Mr. Wentworth then said:

"Dr. Turner, may I again present this award on behalf of the Borden Company and the American Dairy Science Association, commending you on the work that you have done, and as I have said before, with it goes this slip of paper.

"Mr. Chairman, members of the American Dairy Science Association, and ladies and guests. This is the fourth year that this Association has given recognition to those in your ranks of your membership, who have done such meritorious work in research that you have seen fit to name them as

C. W. TURNER

the outstanding men of the year. I am sure that it is considered a privilege on the part of the Bordon Company to join with you on that type of recognition. The company feels, as I know you do, and as has been said formerly here by speakers, that this industry is permanently founded when research is at its best. Tonight you have added to those names who have previously been given this award. I want to mention those other names, who have previously received it so that perhaps it will be fresh in your mind.

1937—Dr. L. A. Rogers and Dr. C. F. Huffman
1938—Dr. K. G. Weckel and Dr. W. E. Krauss
1939—Dr. S. L. Tuckey and Dr. R. E. Hodgson

"So you men of the American Dairy Science Association have named eight men, who are outstanding in the field of research in dairying. Let those men and those names be an inspiration to the rest of you and to the rest who have come in the recent years to do in this industry so that it may better serve the welfare of the producers and the welfare of consumers in this great land. I thank you."

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ABSTRACTS OF LITERATURE

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United States Department of Agriculture

ABSTRACTS OF LITERATURE

BACTERIOLOGY

300. Microbiology of Paper and Paper-board for Use in the Food Industry. F. W. TANNER, Univ. of Illinois, Urbana, Ill., E. WHEATON AND C. O. BALL, American Can Co., New York. Amer. J. Pub. Health, *30:* 256. 1940.

The authors conclude that paper and paper-board made for use in the food packaging industries is a sanitary product of high order. It is not only made from clean, sanitary, raw materials but also results from a manufacturing procedure in which are several absolutely lethal steps, *i.e.*, cooking, bleaching with chlorine, and hot drying rolls. *Escherichia coli* is not found in paper so made. M.W.Y.

301. Microbiological Content of Paper-board Used in the Packaging of Foods. J. R. SANBORN, N. Y. State Agr. Exp. Sta., Geneva, N. Y. Amer. J. Pub. Health, *30:* 247. 1940.

Very few counts in excess of 500 per gram of disintegrated paper-board were found in 2,877 analyses of milk container board from 13 different mills. Slightly higher counts were found in 1,746 analyses of miscellaneous food package paper and paper-board. Differences in the composition of standard agar and incubation at 30° C. rather than at 37° C. did not greatly affect bacterial counts. Bacteria found were the common saprophytic types. M.W.Y.

302. The Production and Utilization of Lactic Acid by Certain Propionic Acid Bacteria. A. S. PHELPS, M. J. JOHNSON AND W. H. PETERSON. Univ. Wisconsin, Madison, Wis. Biochem, J., *33:* 1606. 1939.

The purpose of the study was to ascertain the conditions under which lactic acid would accumulate and to characterize the lactates formed by some of the propionic acid bacteria. Of the three cultures used, *P. pentosaceum*, *P. technicum* and *P. shermanii*, the first produced only l(+) lactic acid from glucose and arabinose, the second only l(+) lactic acid from glucose. The three organisms failed to racemize optically active lactic acid. The growth rates upon the three optical isomerides varied. The presence of both l(+) and d(−) lactic dehydrogenases in these organisms was demonstrated. K.G.W.

303. Strain Variation in the Root Nodule Organism of White Clover. W. D. REID. Proc. Soc. Agr. Bact., Abstracts, p. 43, 1939, Aberystwyth, England.

Clover seeds were incubated with six different strains of nodule bacteria.

In field tests only one strain (N.Z.11) showed any significant increase in dry matter and nitrogen content above the untreated control needs.

L.J.Meanwell

304. Evaluation of Detergents and Disinfectants. A. T. R. MATTICK AND E. SHARPE. Proc. Soc. Agr. Bact., Abstracts, p. 38, 1939, Aberystwyth, England.

The bactericidal values of alkaline detergents have been studied and K, N and O values determined for the pure substances and for various mixtures, commercial or compounded. The presence of 0.1 per cent milk was found to decrease considerably the values obtained in its absence.

L.J.Meanwell

305. Preservation of Starter Cultures. A. T. R. MATTICK AND H. J. ROGERS. Proc. Soc. Agr. Bact., Abstracts, p. 40, 1939. Aberystwyth, England.

The centrifuge deposit of a *St. cremoris* culture transferred to broth +5 per cent serum—dried and frozen under vacuum, retained its vitality after storage at room temperature in the dark for 11 months.

L.J.Meanwell

306. A Hippurate Aesculin Broth for the Identification of Str. Agalactiae. J. G. DAVIS AND H. J. ROGERS. Proc. Soc. Agr. Bact., Abstracts, p. 41, 1939, Aberystwyth, England

Aesculin yeast litmus milk (J. Comp. Path., *52*, 132) gives four of the characteristic reactions of *Str. agalactiae*. Attempts to devise a single medium to two of those remaining (viz., hippurate hydrolysis and orange pigment formation with starch) failed. The only modification found to be of any value was the incorporation of aesculin. This medium may therefore be used in conjunction with yeast dextrose litmus milk (J. Dairy Res. *6*, 125) to identify *Str. agalactiae* with certainty in eradication schemes.

L.J.Meanwell

307. A Homofermentative Tetracoccus Isolated from A.I.V. Silage. A. CUNNINGHAM AND A. M. SMITH. Proc. Soc. Agr. Bact., Abstracts, p. 9, 1939, Aberystwyth, England.

The organism described produced 3 per cent of lactic acid from dextrose in the presence of calcium carbonate. This is not in agreement with Orla Jensen's statement that "the tetracocci are on the whole very weak acid producers." L.J.Meanwell

308. A Motile Lactobacillus Isolated from A.I.V. Silage. A. CUNNINGHAM AND A. M. SMITH. Proc. Soc. Agr. Bact., Abstracts, p. 7, 1939, Aberystwyth, England.

So far as is known, this is the first record of motility in a homofermentative lactobacillus. L.J.Meanwell

309. **Methods of Reproduction of a Spore-forming Bacillus.** J. C. Appleby. Proc. Soc. Agr. Bact., Abstracts, p. 11, 1939, Aberystwyth, England.

An aerobic spore former is described that gives rise to coccal forms which reproduce by budding and the formation of gonidia as well as by fission. Occasionally the cocci revert to the original bacillus. L.J.Meanwell

310. **Technique and Uses of a Method of Direct Microscopic Count.** L. A. Allen. Proc. Soc. Agr. Bact., Abstracts, p. 13, 1939, Aberystwyth, England.

A modification of the Breed method of counting in which a dropping pipette is used. The technique of staining is described. L.J.Meanwell

BUTTER

311. **Application of the Phosphatase Test to Butter.** E. H. Parfitt, Lafayette, Indiana, W. H. Brown and G. W. Shadwick, Jr., Chicago, Ill. Amer. J. Pub. Health, *30:* 240. 1940.

No relation existed between the phosphatase value, yeast and mold count, total bacterial count and keeping quality of the butter. Agreement between two laboratories was closer with short methods than with the one hour method. Flash pasteurization yielded a higher percentage of phosphatase positive reactions than vat pasteurization although some plants which were flash pasteurizing consistently yielded negative phosphatase reactions, indicating that the process was not at fault. Under the conditions with which butter is marketed, a significant number of samples will react negatively when fresh, and positively after receiving treatment comparable to the commercial methods of distribution. M.W.Y.

CHEESE

312. **Holes and All: Swiss Cheese Has Historic Background.** Marie Widmer. The Pacific Dairy Review, *24:* 4, 10. 1940.

In 1291 cheese was treasured as an "essential food." The exportation of it began in the 15th century and with milk and dark bread, formed the staple food of the Swiss people in the 16th century.

Today there are about 2,900 modernly equipped cheese factories in Switzerland. The process of making cheese takes about five or six months; this also includes the fermentation which produces the holes characteristic of Swiss cheese.

Transportation is swift and modern, therefore cheese doesn't suffer from

temperature changes. The variety of cheese is great; the uses, endless. Cheese and butter manufacture in Switzerland absorb 48 per cent of the country's milk production. P.A.D.

313. The Volatile Acidity in Relation to the Flora of Cheddar Cheese. A. T. R. Mattick and E. R. Hiscox. Proc. Soc. Agr. Bact., Abstracts, p. 39, 1939, Aberystwyth, England.

Raw milk cheese show a higher volatile acidity at maturity than heated-milk cheese, this may be due to an early change of flora in raw cheese from streptococci to rod forms. High volatile acid accompanies large numbers of the miscellaneous flora which may stimulate the growth of lactic acid bacteria in raw milk cheese. L.J.Meanwell

CHEMISTRY

314. The Determination of Peptide Bonds in Crystalline Lactoglobulin. Rollin D. Hotchkiss, Copenhagen, Denmark. J. Biol. Chem., *131:* 387. 1939.

The number of peptide bonds in crystalline lactoglobulin has been estimated by determining the increase of amino and carboxyl groups when the protein is completely hydrolyzed by (a) a succession of enzymes, and (b) boiling with mineral acid. The average equivalent of peptide bond corresponds to 115.5 gm. of protein. If a molecular unit of 288 amino acid residues is considered, the total molecular weight is computed to be 33,300, which is significantly different from the figure 39,000 more frequently cited as the molecular weight of lactoglobulin. K.G.W.

315. A Fluorometric Method for Determining the Riboflavin Content of Food Stuffs. A. Z. Hodson and L. C. Norris, Cornell Univ., Ithaca, N. Y. J. Biol. Chem., *131:* 621. 1939.

A fluorometric method of determining the riboflavin content of food-stuffs is described. The results of application of the method are in good agreement with micro-biological methods reported by others. K.G.W.

316. Electrokinetic Aspects of Surface Chemistry. VI. The Interaction of Gelatin with Casein and Egg Albumin at Surfaces. L. S. Moyer and Elsie Z. Moyer, Univ. of Minn., St. Paul, Minn., and Biological Lab., Cold Spring Harbor, N. Y. J. Biol. Chem., *132:* 357. 1940.

"The interaction of gelatin with casein and egg albumin at surfaces was investigated by means of electrophoresis measurements. When particles of collodion are coated with gelatin or egg albumin and then placed in contact with the other protein in the dissolved state, the particles assume a gelatin surface in respect to their electric mobilities. Particles of carbon, quartz,

collodion, or mineral oil placed in a mixture of egg albumin and gelatin likewise became coated with gelatin. These same results were found when the egg albumin solution contained surface-denatured egg albumin and the particles were quartz. In the system, casein-gelatin, over the range between pH 5.8 and 7.8, the resultant surface seems to be determined by the protein which is permitted to coat the particles first. In mixtures of the two proteins to which particles of quartz or collodion were added, the casein seem to diffuse more rapidly to the surface and prevent the adsorption of gelatin for the most part. Particles of casein itself, in the pH range where casein is insoluble, are not influenced much by gelatin except over a pH range which extends from pH 5.2 (slightly above the isoelectric point of gelatin) to 3.7 (a value below the isoelectric point of casein). In this range casein becomes completely coated with gelatin. The nature of the mechanisms and their biological significance is discussed." K.G.W.

317. **Electrokinetic Aspects of Surface Chemistry. VIII. The Composition of the Surface Film on Fat Droplets in Cream.** LAURENCE S. MOYER, Univ. of Minn., St. Paul, Minn. J. Biol. Chem., *133:* 29. 1940.

An interpretive review is made of previous reports on electrokinetic studies of fat droplets, and surface membranes. An investigation of the surface properties of the fat droplets of cream by means of the microscope method of electrophoresis was made. "Milk fat droplets washed with distilled water and suspended in buffer solutions exhibit electric mobilities which are markedly different from those of casein under the same conditions, with the isoelectric point considerably lower. Although unwashed fat globules were not significantly different in their behavior from washed fat droplets at values above pH 5.8, below this figure the electric mobility curves were markedly different, with the unwashed droplets progressively assuming an electrokinetic behavior more nearly identical to that of casein as the pH was decreased. The isoelectric point of the unwashed droplets was not significantly different from that of casein. It was suggested the behavior of the unwashed droplets is complicated by the presence of casein and that pH values at which casein is very slightly soluble the fat droplet surface becomes contaminated with casein. The isoelectric point of casein is dependent to a certain extent upon the ionic strength in acetate buffers, becoming lower in pH value at higher ionic strength. These data are interpreted to be more closely in accord with the evidence of L. S. Palmer for the existence of a complex of phospholipids and a 'membrane' protein, different from other known milk proteins, composing the fat droplet surface."

K.G.W.

318. **The Nature of Sugar in the Milk and the Carbohydrate Metabolism of Lactating Women.** K. M. DAOUD, Biochemical Dept., Faculty of Medicine, Cairo, Egypt. Biochem. J., *34:* 1. 1940.

In lactating diabetics no glucose is secreted in the milk regardless of the existence or absence of hyperglycemia. The amounts of lactose and other constituents of the milk remain within the range for normal individuals. In diabetics, the active mammary glands, contrary to other glands, prevent glucose leakage, possibly by virtue of their synthetic power for lactose, and are capable of maintaining normal milk composition. K.G.W.

319. **Vitamin in Rat's and in Guinea Pig's Milk.** JAMES HOUSTON AND S. K. KON, Nat. Inst. for Res. in Dairying, Univ. of Reading. Biochem. J., *33:* 1655. 1939.

The following values determined by physical and chemical methods for the concentration per 100 ml. of vitamin A, carotene, vitamin B, riboflavin and vitamin C, respectively, in rat's and guinea pig's milks, viz., rat: 0.13 mg.; not measurable, 50–80 I.U.; 0.4–0.8 mg.; 0.4 mg.; guinea pig: 0.09 mg.; 0.011 mg.; 20 I.U.; 0.085 mg.; 29.0 mg.

Compared with cow's milk rat's milk is richer in vitamin B, and riboflavin, but contains much less vitamin C. Guinea pig's milk contains much vitamin C, about half the amount present in average lemon juice. Feeding riboflavin to lactating rats resulted in increased concentration of the factor in milk, but generous administration of vitamin B, or C was without effect. The vitamin B content of rat's milk dropped sharply when a vitamin B deficient ration was used. K.G.W.

320. **Xanthine Oxidase and Milk Flavoprotein.** H. S. CORRAN, J. G. DEWAN, A. H. GORDON AND D. E. GREEN, Biochemical Dept., Cambridge. Biochem. J., *33:* 1694. 1939.

A method is described for preparing a flavoprotein which catalyzes the oxidation of hypoxanthine, aldehydes and dihydrocoenzyme I, and is about 1000 times more active per mg. dry weight than milk. The three catalytic activities though associated with the same flavoprotein can be differentially inactivated. The flavin moiety has been shown to be very similar to, if not identical with, flavinadenine nucleotide. K.G.W.

DISEASE

321. **Bloat in Dairy Cattle.** T. M. OLSEN. S. D. Agr. Exp. Sta. Circ. 27. 1940.

A report on analyses of gases from the rumen of cows which had bloated after consuming various pasture grasses: sweet clover, alfalfa, Sudan grass, sorghum, corn, brome grass and marsh or lowland grass were used in the trials. No striking differences in the kinds of gas found were determinable as between legume and non-legume pastures. CO which is toxic in small quantities in the blood was found to vary in rumen gas, from 0.05 to 0.58 per cent. H_2S, also toxic in low percentage in the blood, is to be determined

in future analyses. No statements are made relative to probable causes of death by bloating, *i.e.*, whether pressure reduces heart and lung action to the lethal point or whether toxic gases are important as a cause of death.

Author's abstract

FEEDS AND FEEDING

322. **Influence of Feeds on Lecithin Content of Milk and Possible Relationship of Lecithin Content to Susceptibility of Milk to Copper-Induced Oxidized Flavor.** I. A. Gould, W. K. Fox and G. M. Trout, Michigan State College, East Lansing, Mich. Food Research, *5:* 2, 131. March–April 1940.

Feeds do not influence the lecithin content of milk, which was found to average .0461 ± .0011 per cent to .0474 ± .0009 per cent when the cows were fed low and high fat rations respectively. The lecithin content of the milk is fairly constant regardless of variations in the percentage of fat; thus, as the per cent of fat in milk increases, the per cent of lecithin in the fatty extract decreases. There is no relationship between the amount of lecithin in milk and its susceptibility to copper-induced oxidized flavor. F.J.D.

323. **Feeding the Dairy Herd.** W. B. Nevens. Ill. Agr. Exp. Sta. Circ. 502: 1–32. Feb. 1940.

A practical brief manual of feeding for dairy farmers. Among the topics included are : (1) qualities of a good dairy ration, (2) classification of feeds, (3) barn feeding, (4) grain mixtures, (5) pasture feeding, (6) method of calculating mixtures, (7) special care at calving time, (8) feeding young stock, (9) special problems in dairy cattle feeding, (10) feeding value of individual feeds. Tables showing feed value yielded per acre by various Illinois crops and nutrients in 100 pounds of various dairy feeds are given. O.R.O.

324. **The Preservation of the Grass Juice Factor in Silage.** B. C. Johnson, C. A. Elvehjem, W. H. Peterson and H. J. Fagen, Univ. of Wisconsin, Madison, Wis. J. Nutrition, *18:* 527–35. 1939.

The "grass factor" which is found in milk from cows on pasture is preserved in forage by ensiling. The A. I. V. and phosphoric acid methods of ensiling gave better preservations of the "grass juice factor" than did molasses. Milk from cows fed phosphoric acid alfalfa silage was found to be approximately as rich in the "grass juice factor" as milk produced by cows on summer pasture. C.F.H.

FOOD VALUE OF DAIRY PRODUCTS

325. **Comparison of Nutritive Value of Refined Coconut Oil and Butterfat.** R. S. Harris and L. M. Mosher, Massachusetts Institute of

Technology, Cambridge, Mass. Food Research, *5:* 2, 177. March–April 1940.

In apparently well controlled experiments, rats were fed complete fat-free diets supplemented, in one group, with refined coconut oil, and in another, with pure butterfat. A control group received a standard stock ration. The experimental diets were normal in all respects except that they contained an abnormally large proportion of fat. The animals fed coconut oil increased in weight more rapidly than those fed butterfat, but the increase was not due to adipose tissue. Animals on both experimental diets developed slight fatty infiltration of the body and liver cytoplasm. No evidence was found of pathological tissue changes in any of the animals. The results indicate, according to the authors, that butterfat and coconut oil, even when fed at rather high levels in a complete diet, are equally harmless to rats and presumably to man. F.J.D.

326. Influence of Sunlight on Flavor and Ascorbic Acid Content of Milk Exposed in Three Different Types of Paper Containers. J. L. HENDERSON, D. C. FOORD AND C. L. ROADHOUSE, University of California, Davis, Calif. Food Research, *5:* 2, 153. March–April 1940.

Three types of paper milk containers of different paper stocks were compared for protective effects against flavor production and ascorbic acid destruction caused by exposure to sunlight. All three of the paper containers exhibited greater protection than did the clear glass milk bottle, but there was considerable variation in the degree of protection afforded by the paper containers. The container providing the greatest protection was one made of thick paper with unbleached or colored inner plies. The destruction of ascorbic acid by sunlight was found to be a useful index of the effect of the sunlight on the flavor of the milk. F.J.D.

327. The Importance of Economical Milk in Human Nutrition. MARIETTA EICHELBERGER, Chicago, Ill. Amer. J. Pub. Health, *30:* 169. 1940.

Summaries of reports concerning the place of evaporated milk in human nutrition are presented. Evaporated milk is popular for infant feeding because of its curd character and easy digestibility. It is a satisfactory source of calcium, phosphorus and nitrogen. Evaporated milk is an important source of vitamins. About 50 per cent of the country's evaporated milk supply is irradiated and about 10 per cent is reinforced with a vitamin concentrate. The need is vital in human nutrition for an economical milk supply. M.W.Y.

328. The Food Value and Economics of Skim Milk. J. S. ABBOTT, Washington, D. C. Amer. J. Pub. Health, *30:* 237. 1940.

Facts are given about the food value of skim milk. Ninety per cent of the food nutrients or food value of skim milk is wasted when it is fed to pigs for conversion into pork. The writer states that there ought not to be any restrictions against compounding skim milk with other foodstuffs for use as human food. M.W.Y.

329. **Whey as a Source of Vitamins and Vitamin Products.** G. C. SUPPLEE, Bainbridge, N. Y. Ind. Eng. Chem., *32:* 238. 1940.

Whey, or a concentrated fraction thereof, has been shown to contain lactoflavin (riboflavin, vitamin B_2 or G), thiamine (vitamin B_1), the antiacrodynia factor (vitamin B_6), prothrombin (vitamin K), provitamin D, the oestrogenic hormone, and by permissible deduction, vitamin E and factor W. The multiplicity of vitamins found in the whey fraction after removal of protein and milk sugar is adequate in water-soluble factors to support growth, reproduction, and lactation. Eight successive generations of white rats have been maintained with a normal life cycle on a restricted experimental diet in which the whey vitamin fraction supplemented with rice polish served as the sole source of all vitamins except the fat-soluble factors carried by a small percentage of cod liver oil. B.H.W.

330. **The Vitamin A Content of Cheese.** A. W. DAVIES AND THOMAS MOORE, Univ. Cambridge and Medical Research Council. Biochem. J., *33:* 1645. 1939.

English cheddar cheese was found in biological tests to have a vitamin A potency of an order (7.5 I.U. per gram) that would be expected from its milk fat content, and from the result of colorimetric estimations of vitamin A and carotene. Colorimetric determinations on other full milk cheese gave similar results. Lower values were found for cheeses of lower fat content. K.G.W.

331. **Adequacy of a Milk Diet for the Rat.** L. R. RICHARDSON AND A. G. HOGAN, Univ. of Missouri, Columbia, Mo. J. Nutrition, *19:* 13–19. 1940.

The addition of iron, copper, manganese and iodine to a milk diet of rats resulted in the production and weaning of almost as many young per litter as did the controls. The experimental animals produced about half as many litters per female as did the controls. The authors concluded that apparently milk is deficient in some nutrient other than iron, copper, manganese or iodine, which is essential for normal reproduction. C.F.H.

332. **The Determination of Ascorbic Acid in Commercial Milks.** W. W. WOESSNER, C. A. ELVEHJEM AND H. A. SCHUETTS, Univ. of Wisconsin, Madison, Wisc. J. Nutrition, *18:* 619–626. 1939.

The authors described a method for determining the ascorbic and dehydro ascorbic acid in raw and commercially pasteurized milk. High pro-

ducing cows do not necessarily give less ascorbic acid per liter than low producers. Milk from the Brown Swiss herd contained the most ascorbic acid per liter followed by Jerseys, Guernseys, and Holsteins respectively.

Samples of raw, certified, certified Guernsey and certified vitamin D milks were only a little below fresh milks indicating but a small loss of ascorbic acid from the cow to the consumer. Commercial pasteurized milk contained about half as much ascorbic acid as fresh raw milk and significantly less ascorbic acid than commercial unpasteurized milks. Mineral modification and homogenization apparently have a destructive effect on ascorbic acid. C.F.H.

333. Why Your Customers Need More Dairy Products. NINA SIMMONDS, Univ. of Calif., San Francisco, Calif. Assn. Bull., Int. Asn. Milk Dealers, 32nd year: 333–338. Feb. 1940.

Emphasis is placed upon the value of milk from standpoint of protein, calcium and phosphorous. Menus are given. For each menu is given the content of the several food constituents and calorific values. E.F.G.

334. The Vitamin A Content of "Light White" Casein. M. K. MAITRA AND THOMAS MOORE. Nutr. Lab., Univ. of Cambridge, and Med. Res. Council. Biochem. J., *33:* 1648. 1939.

"Light White" casein contained enough vitamin A to promote slow growth in rats depleted of the vitamin when included in the diet at the level of 20 per cent. Hot alcohol extracts of the casein were colored yellow and gave blue colorations when treated with $SbCl_3$ reagent. The value of one I.U. per gram may be taken as the approximate vitamin A content of typical casein. Ether and ethylene dichloride, used in the cold, extracted only a small fraction of the fat present. The vitamin A activity of the casein was at least partially retained. K.G.W.

ICE CREAM

335. Factors Affecting Viscosity and Coverage Value of Chocolate Coatings for Ice Cream. HAROLD COLLINS AND J. H. ERB, Ohio State Univ., Columbus, Ohio. Ice Cream Rev., *23:* 1, 28. 1939.

The incorporation of small amount of moisture in chocolate coating for ice cream bars increases the viscosity of the coating and decreases coverage value. Coating to which lecithin was added in amounts up to 0.4 per cent resisted moisture thickening. Results obtained under commercial plant conditions showed that when this amount of lecithin was added, the number of bars coated per pound of chocolate was increased. J.H.E.

336. Ice Cream Cabinet Maintenance. ANONYMOUS. Ice Cream Rev., *23:* 1, 42. 1939.

Moisture in a refrigerating system using F-12 as a refrigerant will freeze at the expansion valve orifice causing it to stick on either the open or closed

position. At this sign of trouble the entire system should be checked for the leak and repaired. Then a suitable chemical dryer should be used to dehydrate the system. Several satisfactory dryers are mentioned.

J.H.E.

337. **New Sweetening Agents for Ice Cream.** P. H. TRACY, Univ. of Ill., Urbana, Ill. Ice Cream Rev., *23:* 6, 35. 1940.

When the manufacturer replaces sucrose in ice cream with substitute sweetening agents, he should expect differences in results. The type of sweetness may not be the same, but this does not necessarily mean a disadvantage. All monosaccharides will depress the freezing point more than will cane or beet sugar, but when they are used in limited amounts this is not a serious problem. The lower freezing point of mixes containining monosaccharides may cause some ice creams (especially high-fat products) to be more palatable and have a more desirable body. Some sweetening agents such as "sweetose" may contain substances that result in a better body in the ice cream; others such as honey may add desirable flavoring constituents. In the selection of the nonsucrose sweetening agent, the manufacturer should be governed by cost as well as by the effect of the sugar upon the flavor and physical characteristics of the ice cream. J.H.E.

338. **Stepping up Sales Despite Price Competition.** ANONYMOUS. Ice Cream Rev., *23:* 3, 34. 1939.

Eliminating all mention of price and avoiding controversial discussion, the Arctic Ice Cream Company, of Kansas City, Missouri, invaded the cut-price market and increased sales by following an advertising plan consisting of three elements: (1) the development of a trade mark in the form of a stylized polar bear cub, which was easily recognizable and which had unusual attention value, (2) the constant repetition of one idea, associating Arctic ice cream with quality, and (3) the promotion of a merchandising idea which contained appetite and flavor appeal. Details of the campaign are described. J.H.E.

339. **Merchandising Quick Frozen Foods.** CHARLES Q. SHERMAN. Ice Cream Rev., *23:* 4, 40. 1939.

Reasons are cited why ice cream manufacturers should be interested in merchandising quick frozen foods. Principles of merchandising these foods are given. J.H.E.

340. **Pineapple Ice Cream.** C. D. DAHLE AND D. V. JOSEPHSON, Pennsylvania State College, State College, Pa. Ice Cream Field, *35:* 4, 24, 44, 45, 48, 49. April 1940.

The results of experiments with pineapple as sources of flavor for ice cream are reported. It was found that best results were obtained when a mixture of unsweetened canned pineapple and 25 per cent sugar was used,

allowing this mixture to stand sufficient time for the sugar to penetrate the fruit before being added to the ice cream. This required 7 hours at room temperature or 12 to 14 hours at 34° F.

It is reported that when ice cream is frozen in a continuous freezer using a fruit feeder, it is best to add the juice to the mix before freezing. Because of improved appearance a new cubed pineapple, especially developed for the ice cream industry, was superior to crushed or tidbit pineapple products. In the case of batch frozen ice cream, crushed pineapple proved as satisfactory as cubed pineapple.

High copper contents in certain pineapple products contributed towards the development of oxidized flavor in ice cream. It is possible to obtain canned pineapple, however, low enough in copper so as not to cause this difficulty.

The authors recommend using 15 to 20 per cent unsweetened or natural pineapple, properly sugared, for flavoring ice cream and give several recipes for batch and continuous freezers. W.C.C.

341. Servicing Ice Cream Cabinets. W. E. WEAVER, Borden Assd. Companies, Toronto, Canada. Refrig. Eng., *39:* 5, following 336. May 1940.

This is a condensed treatment of ice cream cabinet servicing requirements. Careful checking of units at intervals cuts down on failure when cabinets are handling seasonal peak loads. The installation of two compressors, one to handle the ice cream cabinet temperature, and the other the back bar, salad pan, sweet water cooling, etc., at 35° to 40° F. in combination outfits is recommended. The proper use of driers will materially lower service calls. Preventive service pays dividends. L.M.D.

342. Sanitation at the Soda Fountain. J. L. RICE, Com. of Health, New York City. Ice Cream Field, *35:* 4, 19. April 1940.

It is claimed that personal hygiene is one of the greatest problems in connection with public health law enforcement. The author states that all fountain employees should adhere to these rules. (1) All workers must be clean in person at all times, (2) all employees should wear clean uniforms and caps, (3) fingernails and hands should be washed at regular intervals, (4) hair should be neatly combed and a cap worn at all times, (5) hands should be washed after using toilet, (6) periodic health examinations should be required.

The author advocates advertising sanitation and cleanliness, claiming that fountain operators can profitably publicize their employee health rules in order to familiarize the consumers with the high standards maintained. W.C.C.

343. Progress in the Ice Cream Industry. R. A. BRODESSER, Southern Dairies, Inc., Washington, D. C. Refrig. Eng., *39:* 6, 377. June 1940.

Refrigeration is the basic factor in the ice cream industry requiring the largest individual investment in machinery. The use of pre-coolers and headers together with booster compressors makes for flexibility in temperatures and efficiency of operation. Bin type direct expansion coil arrangement in hardening rooms is most satisfactory.

Truck body refrigeration should not be expected to act as a hardening agent in addition to transportation protection. Truck temperature should not be allowed to rise above 10° F. This temperature maintenance may be obtained by a hold-over system, truck-operated compressor, or a CO_2 circulating system.

The author points out the advantages of the sealed non-toxic gas compressor for ice cream cabinet use. It is predicted that in areas where the cost of CO_2 equals that of purchased power, electrically operated compressors will become obsolete. L.M.D.

MILK

344. The Use and Future of Two-Quart and Gallon Milk Bottles. SCOTT FARON, Glass Container Assn. of America. Milk Dealer, *29:* 7, 96–109. April 1940.

The advantages of the two-quart container over the gallon container are discussed. The reaction of milk dealers to these containers is also given. C.J.B.

345. The Milk Dealer's Duty in Stabilizing His Industry. C. W. HOLDAWAY, V. P. I. Dairy Dept., Blacksburg, Va. Milk Dealer, *29:* 7, 54–56. April 1940.

The author points out that the relations between dealers and producers are as important as the relations between dealers and consumers in stabilizing the milk industry. Several methods are suggested for building producer confidence and developing producer services. C.J.B.

346. State Requirements on Sediment Testing of Milk and Cream. ANONYMOUS. Milk Dealer, *29:* 7, 42–44. April 1940.

A tabulation showing the sediment testing requirements and the extent to which they are enforced in 45 states and the District of Columbia. C.J.B.

347. What Do We Know about Consumption of Milk by Consumers. EDWARD FISHER BROWN, Milk Research Council, New York City. Milk Dealer, *29:* 7, 37, 72–76. April 1940.

A report of a study to determine the milk-drinking habits of adolescents and adults. C.J.B.

348. Processing and Sale of Homogenized Milk. ANONYMOUS. Milk Dealer, *29:* 7, 32. April 1940.

A survey by the Milk Dealer in which replies were received from 603 dealers in 46 states and the District of Columbia showed that 216 of these dealers now produce and distribute homogenized milk, and 77 declared that they expect to homogenize milk for bottling purposes some time in the future.

A homogenizing pressure of 2500 pounds to 2999 pounds was used by 113 dealers, and 168 advised that they used a pressure between 2000 and 3000 pounds. One reported a pressure under 500 pounds and 14, under 1000 pounds.

The report on clarification showed that 110 dealers do not clarify, 72 clarify after homogenization and 28 clarify before homogenizing.

The survey also showed that 98 dealers charged the same price as that for unhomogenized milk, 111 received a premium of one cent, and 6 received a premium of 2 cents a quart for homogenized milk. C.J.B.

349. "Oxidase Reaction" of Bacteria in Relation to Dairy Products. C. H. CASTELL AND E. H. GARRARD, Ontario Agr. College, Guelph, Ont. Food Research, *5:* 2, 215. March-April 1940.

An oxidase test is described which is advocated as a means of detecting organisms which may be responsible for oxidative spoilage of dairy products. The oxidase activity of a number of different, common organisms is presented and a discussion of the practical application of the oxidase test as a regular diagnostic procedure is included. The authors believe that interest in the non-living catalysts, which cause oxidation in dairy products, has eclipsed to too great a degree the study of microbial action in this connection. F.J.D.

350. More about Modernizing the Milk Bottle. ANONYMOUS. The Pacific Dairy Review, *24:* 4, 16. 1940.

One of the latest milk bottles is the two-quart size container which is less bulky to use, takes less space in the refrigerator, and is more in line with the family needs. It packs in cases which stand in one quart spaces and makes economical use of truck space. The gallon container may also be used, but the half-gallon is preferable in dairy plants. The two-quart bottle has increased the volume.

The latest development is a new shaped one-quart bottle constructed of tough glass weighing only 17 ounces, instead of the present 22 ounces, and is designed to effect space economy in the ice box. P.A.D.

351. Needle Puncture Method for Determination of the Bacterial Contamination of Paraffined Milk Containers. C. S. MUDGE AND D. C. FOORD, Univ. of Calif, Davis, Calif. Amer. J. Pub. Health, *30:* 273. 1940.

Due to the high incidence of sterile paper milk containers, plating meth-

ods for determining bacterial contamination are difficult to control. The needle puncture method prevents outside contamination. Sterile broth is introduced through the wall of the container, the inoculation being made through a drop of alcohol. After allowing from 30 to 40 cc. of media to flow into the container, the needle is withdrawn, and the hole is sealed with hot, sterile paraffin. The container is incubated for 48 hours at 37° C., after which it is opened and an observation made as to the presence or absence of growth. M.W.Y.

352. Recent Investigations of Goat's Milk. A. K. BESLEY, Beltsville, Maryland. Amer. J. Pub. Health, *30:* 182. 1940.

Milk from the Toggenburg and Saanen breeds of goats was found to be a healthful, nutritious food, not unlike the milk from the Holstein breed of cows in general composition and nutritive value. The goat's milk studied had a curd 31 per cent softer than that of the milk from Holstein cows and a small-sized fat globule of one-half the volume. Data are presented to show that it should not be difficult for goat milk producers to meet the usual requirements of public health officials for the production of milk.

M.W.Y.

353. Accuracy of Plate Counts Made from Milk Products as Affected by the Temperature of Incubation. CARL S. PEDERSON AND ROBERT S. BREED, N. Y. Agr. Exp. Sta., Geneva, N. Y. Amer. J. Pub. Health, *30:* 162. 1940.

Studies on the temperature of incubation and the various types of incubators are discussed. A variation of $\pm 1°$ C. in incubating temperature at 32° C. causes on an average only a 4 per cent variation in count, while a variation of $\pm 1°$ C. at 37° C. causes an average error of more than 25 per cent. Many of the present unsatisfactory types of incubators would be satisfactory for milk control laboratories if the present 37° C. temperature were changed to 32° C. Counts obtained at 32° C. are a more constant percentage of the total maximum counts obtainable than are counts at 37° C.

M.W.Y.

354. Resazurin and Methylene Blue as Indicators of the Hygienic Quality of Raw Milk. S. B. THOMAS, B. F. THOMAS, AND J. DAVIES. Proc. Soc. Agr. Bact., Abstracts, p. 31, 1939, Aberystwyth, England.

The reduction of resazurin to purple-pink takes about half the time required for complete reduction of methylene blue. Mastitis samples are detected more frequently by resazurin. L.J.Meanwell

355. Pasteurized Milk. I. Preliminary Results of a Survey of Plants in the Midlands. A. L. PROVEN AND A. ROWLANDS. Proc. Soc. Agr. Bact., Abstracts, p. 15, 1939, Aberystwyth, England.

Unsatisfactory pasteurization was found to be due to: (a) inaccurate thermograph readings, (b) hand control of steam valves, (c) common pipe lines for raw and pasteurized milk, (d) deliberate under pasteurization.

L.J.Meanwell

356. Pasteurized Milk. II. Raw Milk as a Source of Thermoduric Organisms. A. L. PROVEN AND A. ROWLANDS. Proc. Soc. Agr. Bact., Abstracts, p. 19, 1939, Aberystwyth, England.

High pasteurized counts were traced to unsatisfactory raw supplies due to neglect in cleaning and sterilization of farm utensils.

L.J.Meanwell

357. Pasteurized Milk. III. The Relationship Between the Colony Count and Various Temperatures and Keeping Quality. A. L. PROVEN AND A. ROWLANDS. Proc. Soc. Agr. Bact., Abstracts, p. 23, 1939, Aberystwyth, England.

No indication of the keeping quality of pasteurized milk was obtained from colony count. L.J.Meanwell

358. Present Developments in the Phosphatase Test. F. K. NEAVE. Proc. Soc. Agr. Bact., Abstracts, p. 29, 1939, Aberystwyth, England.

A one hour rapid test has been evolved that is as sensitive as the 24 hour test. L.J.Meanwell

359. The Pasteurization of Skim Milk and Whey by Direct Steam Injection. A. T. R. MATTICK, AND W. A. HOW. Proc. Soc. Agr. Bact., Abstracts, p. 27, 1939, Aberystwyth, England.

Steam is injected after the milk leaves the regenerative section of the heat exchanger. Treatment for 3 seconds at 170° F. resulted in the destruction of *B. Coli* and *M. tuberculosis*. L.J.Meanwell

360. Observations on Resazurin and Methylene Blue Tests. J. G. DAVIS AND C. C. THIEL. Proc. Soc. Agr. Bact., Abstracts, p. 35, 1939, Aberystwyth, England.

Resazurin tests with readings at ½ and 2 hours without inversion give information of great practical value. L.J.Meanwell

361. Trials with Insulating Material for Use with Milk Samples During Transit. H. BARKWORTH. Proc. Soc. Agr. Bact., Abstracts, p. 37, 1939, Aberystwyth, England.

Expanded rubber containers were found to give the most satisfactory protection against an early rise in temperature of milk samples.

L.J.Meanwell

362. Selling Extra and Premium Products on Retail Routes. HAROLD S. WAKEFIELD, Adohr Milk Farms, Los Angeles, Calif. The Assn. Bull., Int. Assn. Milk Dealers, 32nd year: 317–322. Feb. 1940.

The importance—even necessity—of a considerable portion of route business in the form of premium and extra products, if the route is to be profitable, is emphasized. The author states that over half the sales of the company he represents is in the form of these products. E.F.G.

363. Building Fresh Milk Volume through Cooperative Promotions. C. F. DEYSENROTH, The Milk Foundation, Chicago, Ill. The Assn. Bull., Int. Assn. Milk Dealers, 32nd year: 322–327. Feb. 1940.

The lines along which the Pure Milk Association of the Chicago area and the Milk Dealers Bottle Exchange cooperated in promoting the use of milk are explained. The slogans and other material used in the approach to adults are given. The program was directed toward teachers, civic groups and the home. E.F.G.

364. Increasing Sales through Industry Advertising. JOHN MARSHALL, JR., Milk Dealers Assn., San Francisco, Calif. The Assn. Bull., Int. Assn. Milk Dealers, 32nd year: 327–332. Feb. 1940.

Following a decrease in the per capita consumption of milk in the Los Angeles area, a survey showed that 60 per cent of the adults of the city did not drink milk. Cooperative industry advertising representing 80 per cent of the milk sold resulted in definite improvement in the situation. E.F.G.

365. Relation of Bacteria and of Oxygen to the Flavor of Milk Susceptible to Becoming Oxidized. J. G. LEEDER AND E. O. HERRIED. Vt. Agr. Exp. Sta. Bull. 457. 1940.

Cows known to produce milk susceptible to becoming oxidized within a short period were machine milked and, without releasing the vacuum in the pail, samples were immediately drawn by vacuum into flasks. Portions were stored under partial vacuum and under atmospheric conditions. The milks were judged for flavor.

Evacuation and holding milks under reduced pressure of 24–25 inches of mercury usually inhibited the occurrence of oxidized flavors during storage periods of 48 hours at 40° F. The growth of bacteria, normally present or added, decreased the oxygen content of the milks and, in most cases, lessened the intensity of the oxidized flavor. J.M.F.

366. The Dissolved Gases in Milk and Dye Reduction. J. M. FRAYER. Vt. Agr. Exp. Sta. Bull. 461. 1940.

A quantitative study was made of the dissolved gases in milk as they might be affected by sunlight, metabolic activity, evacuation and processing.

Evidence is submitted that: milk is not oxygen free as it exists in the udder; bacterial increases are accompanied by oxygen exhaustion and reduction time decreases; the point at which methylene blue fading is first noted coincides closely with reduction of resazurin to a full pink and occurs at an oxygen level usually less than 0.045 percentage volume which is reached a variable length of time before reduction; a sharp upturn in carbon dioxide content and a definite increase in residual gas content occurs during this period; in milk subjected to sunlight, oxygen is rapidly dissipated, the presence of dye increases initial speed, bacterial growth is inhibited, reduction times are not decreased when oxygen is first depleted and dye in milk can be reduced without evidence of metabolic activity; and that greatly decreased reduction times may be attributable to depletion of all gases by evacuation but augmentation of oxygen content does not of necessity materially lengthen them.

The quantitative nature of gaseous rearrangements incidental to the pasteurization, cooling, and handling of milk were studied.

Reduction of either dye may occur in two steps: (1) Oxygen exhaustion to a minimum level; and, (2) Mobilization and transference of hydrogen to the dye molecule. Author's abstract

367. Refrigeration in Milk Plants. Application Data 13. E. H. PAULSEN, Fairfield Western Maryland Dairy, Baltimore, Md. Refrig. Eng., *39:* 5, 293. May 1940.

Applications of modern refrigeration practices in connection with country handling of milk and the cooling and storage of milk in city plants are described. Some discussion is devoted to by-product refrigeration demands. Items to be considered in milk plant design to achieve the most efficient usage of mechanical refrigeration equipment are stressed. L.M.D.

PHYSIOLOGY

368. Activity of Progesterone in Spayed Females not Pretreated with Estrin. HANS SELYE, McGill Univ. Proc. Soc. Exp. Biol. and Med., *43:* 343. 1940.

Experiments showed that the daily administration of 15 mg. of progesterone to spayed rats produced progestational changes in the endometrium, vaginal mucification, and mammary gland development similar to that seen in late pregnancy. It was concluded that progesterone can exert all its characteristic actions in spayed rats without sensitization by estrogens. R.P.R.

369. Studies on the Bovine Electrocardiogram. I. Electrocardiographic Changes in Calves on Low Potassium Rations. J. F. SYKES AND B. V. ALFREDSON, Michigan State College. Proc. Soc. Exp. Biol. and Med., *43:* 575. 1940.

Four calves were placed on a semipurified ration which analyzed 0.10–0.12 per cent potassium. Four control calves received the same ration except that potassium was added to bring the level to 0.35 per cent. Calves were placed on this ration at 160 days of age. Electrocardiograms were usually taken at monthly intervals, serum potassium determinations were made on all calves at 2-week intervals, and plasma calcium, phosphorus, and magnesium determinations were carried out at weekly intervals. The lowest serum potassium level of 4 experimental animals was (in mg. per cent) 10.2, 11.3, 10.7, and 13.8. The serum potassium values for the 4 control calves averaged respectively (in mg. per cent) 21.4, 20.4, 20.5, and 21.6. The calcium, phosphorus, and magnesium plasma values remained within normal limits in both groups. Three of 4 experimental animals showed pronounced changes in the electrocardiogram, the outstanding change consisted in a pronounced increase in the duration of the QRS. R.P.R.

370. Studies on Bovine Electrocardiogram. II. Bundle Branch Block. B. V. Alfredson and J. F. Sykes, Michigan State College. Proc. Soc. Exp. Biol. and Med., *43:* 580. 1940.

Branches of the His-bundle were sectioned in a group of calves and dogs. Electrocardiograms were obtained before and after section. In 6 instances the presence of complete bundle branch block was proved by the onset of complete A–V block and bundle branch block was successfully produced in 14 calves, and in 10 dogs. Changes in the duration and form of QRS after section of the branches of the His-bundle were much less pronounced in calves than in dogs. The difference was attributed to differences in the distribution of the intraventricular conducting system. R.P.R.

371. A Comparison of Methods of Assay of the Lactogenic Hormone. A. G. Bergman, J. Meites and C. W. Turner, Univ. of Missouri. Endocrinology, *26:* 716. 1940.

Three methods of assay of the lactogenic hormone, of increasing sensitivity, depending upon the proliferation of the crop gland of the common pigeon were compared. Using the McShan-Turner pigeon unit as a standard, it was shown that the Reece-Turner method required only 4.5 per cent as much hormone and the minimum micro-unit only 0.56 per cent as much hormone to produce a unit response. In comparison with the pigeon methods, 272 McShan-Turner units were needed to induce copious lactation in pseudo-pregnant rabbits. Evidence was presented which indicates that the AP factor which stimulates pigeon crop gland proliferation is identical with the factor which initiates lactation in mammals. R.P.R.

372. The Relation of the Anterior Pituitary to Bile Production. O. B. Houchin and C. W. Turner, Univ. of Missouri. Endocrinology, *26:* 821. 1940.

The average hourly secretion of bile by 7 female guinea pigs weighing between 280 and 370 gm., taken at a definite time of the day under avertin and ether anesthesia, was found to be 2.94 cc. with a range of 2.5 to 3.2 cc. Following the injection of 25 mg. of an initial extract of the anterior pituitary, there was a rise in bile secretion extending from 4 to 8 hours. The average hourly production of bile from 13 injected animals was 5.45 cc., an increase of about 85 per cent. R.P.R.

373. **Growth of Vitamin Deficient Rats Treated with Thymocrescin.** ALBERT SEGALOFF AND WARREN O. NELSON, Wayne Univ. Endocrinology, *26:* 860. 1940.

A purified aqueous extract, thymocrescin, was prepared from calves' thymus glands. The preparation agreed closely with published chemical analyses. No growth-promoting or gonadotropic effect could be demonstrated upon 18 rats on a thiamin-deficient diet or upon 8 rats on a horsemeat diet. Attempts to immunize 8 young guinea pigs to thymocrescin were unsuccessful. R.P.R.

374. **The Effect of Adrenalectomy on the Ketosis Produced in Rats by Anterior Pituitary Extract.** REGINALD A. SHIPLEY, Western Reserve Univ. and Lakeside Hospital. Endocrinology, *26:* 900. 1940.

Adrenalectomy did not prevent the ketonemia which was induced by an anterior pituitary extract in fasted rats; however, the response was reduced. There were fewer adrenalectomized animals than normal animals which manifested a rise in blood acetone bodies sufficient to exceed the renal threshold. Hence there were fewer in the operated series which showed ketonuria. No evidence was found for the existence of an elevated renal threshold for acetone bodies after adrenalectomy. R.P.R.

375. **Symposium on Carbohydrate Metabolism.** C. F. CORI, SAMUEL SOSKIN, C. N. H. LONG AND F. G. YOUNG. Endocrinology, *26:* 285. 1940.

An excellent review on carbohydrate metabolism. It consists of the following papers:

1. Glycogen Breakdown and Synthesis in Animal Tissues. Carl F. Cori, Dept. of Pharmacology, Washington University.

2. The Liver and Carbohydrate Metabolism. Samuel Soskin, Depts. of Metabolism and Endocrinology, Michael Reese Hospital, and Physiology, University of Chicago.

3. The Adrenal Cortex and Carbohydrate Metabolism. C. N. H. Long, B. Katzin and Edith G. Fry, Laboratory of Physiological Chemistry, Yale University.

4. The Pituitary Gland and Carbohydrate Metabolism. F. G. Young, National Institute for Medical Research. R.P.R.

MISCELLANEOUS

376. Requirements of Good Water Supplies for the Dairy Industries. K. G. WECKEL, Dept. of Dairy Industry, Univ. of Wisconsin, Madison, Wis. Milk Dealer, *29:* 7, 40–41, 66–70. April 1940.

Water supplies used in dairy plants are discussed from the following standpoints: (1) bacteriologically acceptable, (2) freedom from particles, sediment, suspensions, and oil film, (3) inert chemical properties, (4) availability in volume, (5) low temperature, (6) uniformity in composition, (7) acceptable mode of transmission. C.J.B.

377. Whey Solids in Candy. B. H. WEBB AND C. F. HUFNAGEL, Bureau of Dairy Industry, U.S.D.A., Washington, D. C. Food Research, *5:* 2, 185. March–April 1940.

Sweetened condensed, Cheddar-cheese or Swiss-cheese whey was, in general, the most satisfactory of the cheese wheys for candy use. Plain condensed wheys were also suitable, but their perishable nature was a serious handicap in commercial use. Excellent candy containing up to 40 per cent of whey solids could be made, the whey replacing in part, sugar, skimmilk and corn syrup. Directions for the manufacture of various types of whey candy, including formulae are presented. F.J.D.

378. Casein Plastics. GEORGE H. BROTHER, Urbana, Ill. Ind. Eng. Chem., *32:* 1, 31. 1940.

A short review of the past and present status of the casein plastics industry is presented. Casein plastic is a result of a reaction between casein and formaldehyde. Various modifications and improvements in the manufacture of casein plastics have been made since the commercial possibilities of the product were first recognized in 1897. The industry has been seriously handicapped by a lack of fundamental information on the structure and properties of proteins. B.H.W.

379. Maintenance and Depreciation. C. T. BAKER, Atlanta, Ga. Ice Cream Rev., *23:* 3, 84. 1939.

To keep property and machinery in good physical condition requires vigilance and good judgment. Improper erection and insufficient or improper foundations influence the life of machinery. J.H.E.

380. Production, Processing, and Storing of Fast Frozen Foods. C. J. MEISTER, Fairmont Packing Co., Fairmont, Minn. Ice Cream Rev., *23:* 3, 34. 1939.

The handling of vegetables for fast freezing is discussed. Enzymatic action taking place during storage in the frozen state is said to be detrimental. Proper blanching of vegetables destroys the enzymes. The desir-

able temperature of storage is zero °F. and the temperature should be constant. When the temperature goes up, unless the package is hermetically sealed, the air will go out, taking some moisture with it. When the temperature is lowered, the air will pass back into the package. The package virtually "breathes" if the temperature is not kept constant. J.H.E.

381. Excessive Plant Operating Costs—The Penalty of Ignorance and Neglect. C. T. BAKER, Atlanta, Ga. Ice Cream Rev., *23:* 4, 21. 1939.

The reason for refrigeration operating troubles in two plants are described. Inadequate condensing water and infrequent defrosting of evaporating coils were principal sources of loss of capacity. J.H.E.

382. Successful Farm Refrigerator Fills Many Uses. FRED ERBACH, Chicago, Ill. Refrig. Eng., *39:* 6, 361. June 1940.

A combination refrigerator, one to not only cool and hold milk, freeze a slab of ice, and store frozen foods, but also preserves fresh fruits and vegetables is advocated. It is stated that there is a total market for about 1,200,000 electric units of this sort and 3,000,000 gas driven units. The author suggests essential operating features of such cabinets and presents design features. L.M.D.

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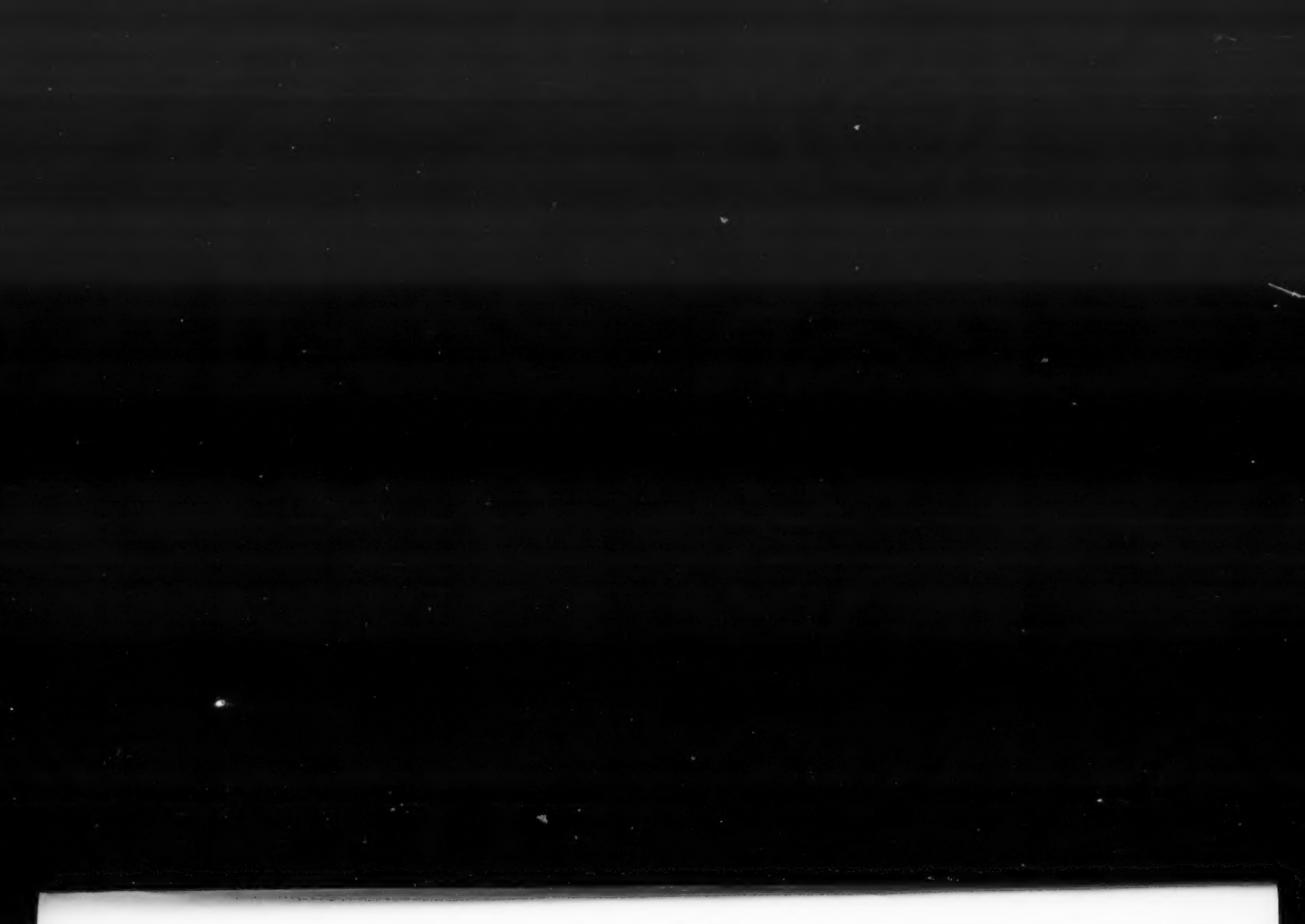
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